MAY 1998

ANALOG

SCIENCE FICTION AND FACT

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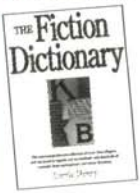

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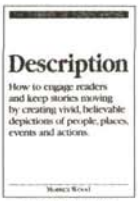

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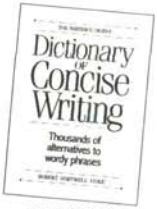

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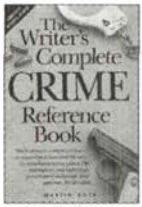

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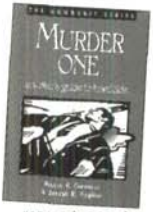

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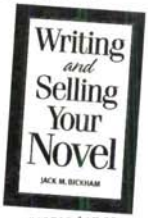

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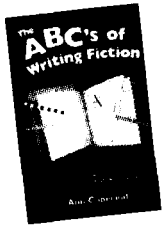

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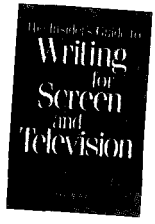

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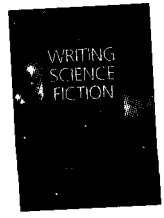

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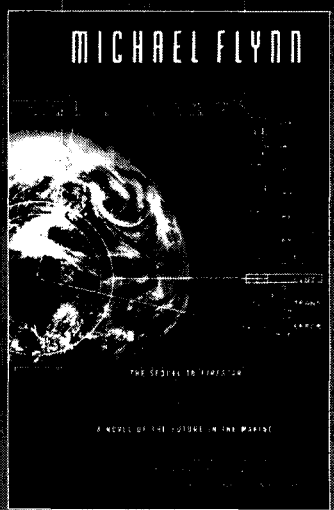

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EDITORIAL Stanley Schmidt

SNAKES OR PAYCHECKS: *IS* THAT THE QUESTION?

There is an area north of New York City—I hesitate to identify it too specifically, lest it attract too much attention from outside—that is highly prized by many people for its scenic beauty and natural diversity. This area, in fact, is considered by some to be the birthplace of the environmental movement in late twentieth-century America. Much that has happened since can be traced back to the protest that stopped plans for a power plant that would have meant seriously defacing one of the most scenic mountains in this area in the 1960s.

Well, they're at it again—both developers and protesters—and my observations of the process prompt me to comment on some of the factors involved in such cases generally.

These observations happened almost unwittingly; I hadn't intended to go to a political demonstration. I thought I was just going on a hike, one I'd seen announced in an area I was unfamiliar with but interested in. I usually avoid organized hikes, especially with large groups, but in this case it seemed likely to be worthwhile. Published information on trails in this area was unusually sketchy, so going with somebody who knew them seemed a good way to learn about them. Besides, I wasn't expecting a big group. Even though I knew the mountain in question was threatened with a large-scale open quarrying operation, my impression was that the group running the hike was a relatively small one in which I knew several members, and that the hike was just a chance for interested people to familiarize themselves with the area.

What I found when I got there was quite different. The group through which I'd heard about the event was only peripherally involved; a different group had organized it, its main purpose was to rally opposition to the mining permit, and there were many dozens of people there, most of them unfamiliar. There *were* hikes, all of which looked as if they were going to be too large for my tastes; but before that there was distribution of pamphlets and remarks by speakers from several environmental organizations, explaining what the proposal involved and why they hoped their lis-

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teners and fellow hikers would join them in opposing it.

And there were hecklers. Gathered at one side of the crowd was a group of mine workers wearing signs that said things like "SNAKES OR PAYCHECKS?" and "WHO WILL FEED OUR CHILDREN?" From time to time they interrupted the speakers with shouted jeers, and one of them tried to get his own time at the microphone. Those in charge declined, politely but firmly—and probably wisely. "This is our rally," one of them said. "You're welcome to hold your own at another time and place." Certainly the issue should be debated, but there would be other times and places set aside specifically for that. And when it happened, it would surely not be fast or pleasant. Letting it start during an hour of gathering before a hike was unlikely to be productive for either side.

But I was intrigued by the miners' signs and interjections, and I do think they warrant some comment now—though I doubt that my comments will be quite what they'd prefer.

First off, the choice is not as plain and clear-cut as "Snakes or paychecks?" Reducing things to such rudimentary and loaded dichotomies is simplistic sophistry and undermines respect for anyone who indulges in it—no matter *what* side they're on. Few of those fighting to preserve the mountain had preserving snakes as their only goal, or even an important goal—though probably most of them would cheerfully acknowledge that it would be a minor side effect of what they were really after. What they were after was saving not "snakes," *per se*, but the integrity of the mountain and the whole attached ecosystem—which happens to include snakes (among them one endangered species), but also includes a great many other things.

Second, the proper answer to "Who will feed our children?" should be, "*You* will." If you weren't prepared to do so, you shouldn't have had them—and nobody ever promised you that you'd always be able to do it the same way. Times are changing faster than ever, and most people can expect to have to change careers at least once during their lives.

In this particular instance, it isn't clear that anybody's going to have to do anything even that drastic—at least, right away. It's true that, given the way our economy is now set up, people need jobs. But these jobs are

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not the only jobs in the world, and this mountain is not the only source of gravel in the world. To the extent that more gravel is needed, it should be possible for quite some time to come to get it from places, and in ways, that don't involve conspicuously damaging highly visible natural or historic landmarks. (The mountain that started all this is both.)

The mere fact that a proposed project creates jobs does *not* automatically make it a good idea. There's money in bank robbery, too, but few would recommend it as a career for an ambitious young person.

In the case I'm alluding to, the faction trying to save the mountain had demonstrably thought about both economic and other considerations. They pointed out repeatedly and persuasively that, in the long run, this area is likely to prosper more from tourism and its spinoffs than from grinding up its mountains and selling them by the ton. The mine workers, on the other hand, showed no sign of having considered any facts except that mining the mountain would give them jobs that they might not have otherwise.

And that gravel would still be needed and would have to come from *somewhere*. Fair enough, for now; but I repeat, it does not have to come from one of the most conspicuous and scenic vistas, or one of the largest relatively undisturbed tracts, in the area. If this mountain isn't mined, the miners have at least two options. If mining gravel is the only thing they can imagine themselves doing, they can go where it's being done. Or they can learn to do something else.

Sure, those courses of action are not as easy or convenient as they

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might like. If alternate quarry sites are some distance away, working there may require a long commute or relocation. Changing to a different kind of work may require learning new skills. So what? Plenty of other people have had to do those things, and have survived the experience. Why should gravel miners be guaranteed a lifetime exemption from that possibility?

You can't ignore the guys with the pickets. They may be thinking only of economics, and some of us may consider other considerations more important—but it's a lot easier to feel that way if your economic necessities are taken care of. The miners are quite naturally and properly concerned about theirs, and it's unsurprising—if shortsighted—that they'd prefer to keep them taken care of in the simplest, most familiar way. If you know a reason why they can't or shouldn't, and alternatives they can pursue, you may have to tell them—in their own terms. Even if you think noneconomic considerations justify doing something a certain way, it's prudent to be able to also couch your arguments in economic terms for those who don't understand anything else.

However, in the longer run, some more fundamental rethinking *will* be necessary—for all of us. The whole way of thinking that says you must keep indefinitely finding new sources of either jobs or gravel is invalid and must be changed. If you're *really* going to keep needing new gravel forever and ever, and Earth is the only place you can get it, you may be able to spare this mountain this year, but sooner or later you *will* have to mine it. If you pursue the miners' arguments to their logical conclusion, it's only a matter of time till *everything* has been mined for gravel, jobs, or similar commodities.

There are, of course, several options which can provide a better future than letting the miners and people like them do whatever jobs somebody offers them, regardless of noneconomic costs. One that's probably obvious to readers of this magazine, at least in the area of gravel and other minable commodities, is space. There is *lots* of gravel in the asteroids, for instance. If you're going to keep needing more and more raw material, and you don't want to strip-mine every inch of Earth, sooner or later you're going to *have* to start getting some of it elsewhere.

Another thing we can do is learn to *use less* raw material. One way to do that is by recycling. If you need gravel to repair old roads, for instance, you may be able to get at least part of it by reusing what's already there, or what you get from old roads that have been abandoned.

Of course, if you want gravel for building *new* roads, you may have to get it from new sources. But you can't keep building new roads indefinitely, either. Eventually you'll run out of places to put them, and destinations worth driving to. Nor can we keep building more and more houses and business places indefinitely—though, so far, many of us seem determined to try. And the perceived need to do so will persist as long as people remain locked into the idea that they should

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keep increasing their own numbers without limit. They can do it for some time beyond where we are, of course; but the more of us have to share everything—material and otherwise—the lower the *quality* of life will become for all.

So we really need to break out of that mentality, that way of thinking that says we must keep making more and more people, and more and more roads and buildings to support them. And, finally, we must break free of the mentality that says that jobs are an *intrinsic* good rather than a means to an end. Yes, everybody needs a job, now—but the nature and extent of that need is a consequence of the way our society has evolved, not an innate law of nature. Originally people worked to meet needs—their own and their culture's. A socioeconomic system based on jobs for pay evolved to insure that those needs were met and that everybody (a) contributed to meeting those of society, and (b) earned the satisfaction of his or her own needs.

Now our society has outgrown the existing system. Its needs have changed dramatically, but it hasn't yet realized that fact or figured out what to do about it. Technology has greatly reduced the amount of personal labor necessary to meet basic needs, but the culture is still put together in a way that requires everybody to be employed for something approximating "full time." So a great deal of work now has nothing to do with basic needs, but is created primarily to provide employment. That work still consumes resources, and so a destructive—and quite unnecessary—cycle perpetuates itself.

We are facing an unprecedented opportunity that most of us persist in viewing as a problem. If and when we as a people recognize that fact, and figure out how to seize the opportunity—to restructure our lives so that most of us can get the things we need *without* a lot of unnecessary work-for-work's sake and wasteful use of resources—both we and our world will be much better off. ■

The computer defies clichés for success: bigger isn't better; smaller is better. To get more, you don't have to pay more; Just wait for next year's cheaper, faster, more powerful model.

— Karla Jennings

I always did do better work while being patted on the back than while being kicked in the seat of the pants.

— E. E. "Doc" Smith

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Part Two of Four

Joan Slonczewski

THE CHILDREN STAR

Certainty can take a long time to achieve—longer than many humans can wait.

Illustration by Darryl Elliott

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SYNOPSIS

On the planet Prokaryon, all living organisms grow in rings. Tire-shaped zoöids graze over fields of loopleaves, and flyers with helicoid propellers fill the forests of arch-trunked singing-trees. As yet, none of these life forms appear intelligent; but the forests and fields are spaced in orderly arrays that imply the existence of "hidden masters."

Prokaryan DNA is triplex, and the biochemistry is full of native structures toxic to humans. To live there, human colonists have to be "lifeshaped," genetically engineered by the ageless Elysians who dominate interstellar trade. But lifeshaping is most successful on infants, whose physiology is immature and could be altered more easily than in adults. Thus Prokaryon has been colonized mainly by children, and by "sentients," intelligent machines who outgrew their makers. Elysians consider lifeshaping of non-Elysians expensive and ineffective. Their commercial developers want to terraform Prokaryon to make it habitable, though its native ecology—and any hidden intelligence—would be destroyed.

On Prokaryon, a religious order, the Spirit Callers, has founded a colony of orphans rescued from the plague-ridden world of L'li. The colony is run by sentients, the ***Reverend Mother Artemis*** *and* ***Brother Geode****, and by the human* ***Brother Rod****. Rod had been a student at the military academy of Valedon before he converted to the Spirit Callers. After years of genetic treatment, Brother Rod can live on Prokaryon without a protective "skinsuit," but he can still only eat imported food.*

As the story opens, Brother Rod and Brother Geode are returning from L'li with four new orphans to join the Spirit Colony. One of the orphans, ***'jum****, turns out to be several years old, already too mature for easy lifeshaping. 'jum will need to stay many months or years on Station, the sentient satellite that prepares visitors for the planet. Brother Geode warns that her treatment will tax the colony's resources. Brother Rod feels guilty, but knows that the Spirit called him to save her.*

Back at the Spirit Colony, a "tumbleround," a giant Prokaryan plant-animal ridden with insect-sized helicoids, has invaded the garden, and Brother Rod needs to dig the foul-smelling vermin out. Then he finds that the colony's sentient Doctor Patella has had an accident, fallen down the side of a mountain where the children mine sapphires. Now, Mother Artemis tells him he will have to take sick children on a journey through the treacherous singing-tree forest to get treatment from ***Sarai****, a reclusive xenobiologist who lives in the mountains.*

Sarai agrees to treat the children, but one of them, ***Gaea****, will need to stay at the mountain encased in the calyx of a giant plant that will regenerate her spinal cord. Sarai warns that her own xenobiology research has produced clues to the identity of the "hidden masters," the mysterious intelligent race that manages Prokaryon's climate.*

Most of the research in xenobiolo-

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gy is actually going on at ***Station****, where sentients and graduate students are attempting to communicate with various species to prove that they are the "hidden masters." Their current candidate is the singing-trees, which send strange "songs" to each other and transmit light signals over the forest canopy. Rod is skeptical, because the scientists have claimed to communicate with Prokaryan creatures many times before, but it came to nothing. Nonetheless, to earn money that the Spirit Colony desperately needs, Rod signs on to assist the field work of a xenobiology graduate student,* ***Khral****. Khral works for Elysium, but her parents were gorilla hybrids, former slaves on a less developed world.*

Khral's theory is that singing-trees use symbiotic "microzoöids," ring-shaped Prokaryan microbes, to generate messages and transmit through light. She and Rod climb up the singing-trees to collect their light-pods, which contain the light-emitting microzoöids. Khral, unlike Rod, has to wear a skinsuit, an expensive, technologically complex sheath to filter out the planet's toxic chemicals.

In the distance, they catch sight of a starship entering the atmosphere. The ship crashes. It turns out to be a ship of illegal immigrants from L'li. If any passengers survive the crash, without skinsuits they will soon die.

Part II

Chapter 7

The ship of L'liite emigrants had evaded Prokaryon's sparse security satellites and crash landed on the western curve of Spirilla. Survivors were seen running off into the singing-trees. Station's medics did not try too hard to find them.

Rod confronted Station. "You can't let them die," he told the omnipresent voice in his cubicle. "We'll take them in. If you treat them, we'll feed them."

"You know better, Brother Rhodonite." The mind of the Station seemed to close in on him. "I haven't the facilities, much less the funds, to treat a hundred adults for the next decade. It's time you faced the truth, Spirit Caller. Your own colony's immigration is suspended until your last child leaves the clinic."

Rod clutched his fists. How many babies would they lose because of the extra costs from 'jum, the older child? Yet how could he have left 'jum on that cliff? —he wondered for the hundredth time. The Spirit does not count lives in credits.

He turned to the holostage and called the colony. "Those L'liites—they're human beings out there, untreated. They'll die within days. Can't we do something?"

Geode extended his eye stalks. "If only the Spirit Council could raise funds to lifeshape them."

Mother Artemis looked down, her snakes of hair twisting and untwisting futilely. "Alas, the order is hard pressed just to maintain our own colony. But I will send our Reverend Father a neutrinogram."

Rod frowned. "That will take another two days. The Fold ought to do something."

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"The Fold, indeed." Geode's eyestalk twisted into a rude gesture. "They've turned their backs. But Diorite's taken a crew out to track down survivors."

"Good for him. Perhaps they'll get found before it's too late."

"Yes," agreed Mother Artemis. "And Feldspar has done a world of good for us. He got most of our harvest in."

"And he has such good taste in literature," added Geode.

"How are the children?" Rod asked.

"Haemum has found a medical education program," said Mother Artemis. "She is making such progress—thanks to you, Rod."

He looked aside. "The Spirit called us well. And the others?"

"T'kun has an earache and Chae has some kind of rash. But we can manage."

What was she thinking?—he wondered. They could not bring every sickness to Sarai, that mad lifeshaper on the mountain. How could he have left little Gaea to her treatments? *If the stem breaks, she will die.*

Diorite's crew tracked the L'liites for two weeks, but the few survivors had vanished, preferring death to recapture and repatriation. Rod thought of them lost in the singing-tree forest with nothing to eat but poison. Their souls troubled his dreams. Late at night he would toss the covers off his bed and get up, taking some comfort from watching 'jum fast asleep, her mouth and eyes tightly wrinkled shut in a childish look, so different from her seriousness when awake.

One morning Sarai appeared on the holostage. "This child," she said without preamble. "Come and get her, right now."

"What's wrong? Is Gaea ill?"

"She's as well as a two-year-old ever gets," Sarai grumbled, "and then some. She's tearing up my lab."

Gaea healed—the thought burst upon him like sunlight through clouds. Rod hurried to find Khral in her laboratory, culturing microzoöids out of light pods. He hesitated to disturb her, but she looked up with a smile, her hands and arms gloved in transparent nanoplast. The tabletop holostage showed the microzoöids—magnified, ring-shaped cells with occasional buds on one side.

"Could I borrow transport from you?" he asked. "I have to pick up Gaea from Sarai's mountain, and my old lightcraft isn't precise enough." It would probably try to land atop the arch of a singing-tree.

"I can't leave right now," Khral said, "but Quark will take you down."

"What about 'jum?" he remembered suddenly. After three months of treatment, 'jum had still not been cleared for her first exposure to Prokaryon. "It's short notice for a sitter."

Khral's simian brow wrinkled. "Elk's mate can't take her; he's sick with some bug or other, must have caught it on his last passage. Wait—'jum can borrow my skinsuit, and go with you."

Rod felt overwhelmed. "You are too generous."

Khral wrinkled her face in imitation of Sarai. "'Bother all that.'"

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So, with some coaxing, 'jum had her skinsuit put on. It started as a thick disk of nanoplast placed upon her head. The disk thinned itself out, its edge traveling down around 'jum's scalp, setting the filter at her mouth, while the rest of the material traveled downward and outward around her limbs, fusing at last. On her head a light blinked to show the covering was complete. The girl took it well, only shuddering once.

"What a trooper," said Khral. "I was worried that a child wouldn't stand for a skinsuit."

"'jum has endured many strange things in her life," Rod pointed out. "Just think, 'jum— you'll see Prokaryon for the first time."

Quark soon set them down on the trail by the waterfall; a big improvement over two days' journey, Rod thought, suppressing a touch of envy.

"My eye, please," Quark reminded him.

Rod placed the eyespeaker on his shoulder, where the nanoplast immediately molded to fit. Then he let 'jum take a look around outside. "It's cold," she observed. "It's a much bigger mountain."

He smiled with a hint of sadness, recalling the wretched hill above Reyo. "No apartment windows to count, either. But you'll see some day, where we live at the colony is much warmer and flatter." He led 'jum down the ledge to Sarai's door, which was wide open for once. They walked into Gaea's chamber. There, the remains of the leafy calyx lay dried out on the floor, while little Gaea was running— running from one wall to the next, then bouncing off with a whoop and running again.

Sarai shook her head. "She came out running and hasn't stopped. She never learned to walk."

Seeing Rod, Gaea ran straight to him and bounded into his arms. "Zoöids, Brother Rod—let's go see zoöids!"

The joy that Rod felt was indescribable, a feeling that he could not remember for ever so many years before. He felt the child all over, her fuzzy head, her wiggling arms; it was too much to be true. "Sarai, I don't know what we can ever do to repay you."

"Bother." Sarai turned to 'jum. "What's wrong with this one? The plague? I can't treat someone through a suit."

"This is 'jum Ghana, our last Spirit Child to come home from Station," Rod explained. "She loves numbers."

"Really." Sarai eyed her more closely. "Name two squares that add to a third square."

'jum said, "Fifteen squared adds with one hundred twelve squared. And fifty-one squared adds with one hundred forty. But my favorite is . . ."

Sarai stared open-mouthed. Rod had never seen her look actually surprised before. "That's no child," she exclaimed. "It's a sentient."

". . . sixty squared adds with ninety-one squared," jum finished. "But I can add regular, too," she said defensively. "Five thousand and twenty-three plus nine thousand two hundred and eighty-seven makes fourteen thousand three hundred and ten."

"It's the skinsuit," Sarai insisted. "A

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sentient skinsuit; you can't fool me."

Rod laughed aloud, then he checked himself, remembering, this was Sarai after all. "We are quite proud of her."

Sarai stared at 'jum long and hard. "So. Tell me, 'jum," she said more quietly. "What do the numbers thirty-seven, one forty-nine, and ten thousand seven have in common?"

"They are all . . . orphans," said 'jum.

"Just so. 'jum Ghana, come and take a look at those 'orphans.'" Sarai led her down the hall to her laboratory, Rod following behind with Gaea held tight in his arms. Pods hung from vines, like the one that Sarai had dipped into a vat, calling it "genocide." A table-top holostage displayed a microzoöid cell, like the ones in Khral's laboratory. The ring-shaped cell was filled with twisted fibers. "These are spiro-jointed polymers," Sarai said, pointing to the fibers. "These polymers can receive photons and emit them—that is, they glow. Now why do you suppose this cell always emits photons in bursts of 'orphan' numbers? Thirty-seven, forty-three, ten thousand seven?"

"It likes to count," 'jum guessed.

Sarai nodded slowly. "Somebody is trying to tell us something."

"Where did those cells come from?" demanded Rod.

She smiled sweetly. "I grew them in culture, of course."

"But what creature—"

"I don't believe it." At Rod's shoulder, Quark interrupted, in a decidedly nasty tone. "I don't believe one bit of it."

Sarai gave his shoulder an indignant look. Alarmed, Rod tried to look around into Quark's eyespeaker. "Peace, Citizen. I'm sure that Sarai—"

"*I* don't believe you can culture much of *anything* out here," Quark went on. "Why, look at all those Elysian reagents you begged from Khral last time."

"Of all the nerve." Sarai swung her enzyme secretors out of the way. "So that's the thanks I get. You won't find my door again."

"I'll bet you a hundred credits nothing's growing in there."

At that Sarai smiled. "Ah, I see your game now." She thought for a moment. With a shrug, she plucked one of the culture pods and tossed it to Rod. Rod caught it and held it gingerly in his palm. "Check it out; they'll last long enough to give you a signal. Don't ask me for the formula."

By the time they got back to Station, Khral had her lab set for the specimen. Microzoöids making prime numbers—just what we're looking for."

Rod caught Gaea before she climbed up onto the equipment. "Did Sarai's microzoöids come from singing-trees?"

"She didn't say," said Quark. "She said they wouldn't last long—so let's get the photosensor up."

Station's voice responded. "Photosensors have already penetrated the pod. I'm getting some readings . . ."

"Rush the analysis," said Khral. "in case some ingredients have a short half-life." She looked at Rod. "The culture conditions might tell us what organism was their host—and sent their message."

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Rod gave the pod a wary glance. Was this the Prokaryan equivalent of a snake-eye reporter?

"All right," said Station, "watch the holostage. Pulses visualizing now, time lapse factor one thousand."

The space above the holostage went dark, and the room lighting dimmed. A green dot appeared, blinking several times until Rod lost count. Then another dot, more orange, and another. The colors seemed to range from green through violet.

"Those are the microzoöids," said Khral. "But there are so few left . . ."

There was something peculiar about the those patterns of light pulses. Rod felt a sense of dread at the unknown. He held Gaea tight, as if he could protect her.

At his side 'jum watched intently. "Twenty-nine . . . seven . . . sixty-seven."

"Some of the pulse numbers are prime," Station agreed. "We'll have to do the statistics."

Khral jumped twice with excitement.

"Analysis complete," said Station. "A highly complex growth medium, with a large number of undefined components. We can define them, but it will take another day."

Khral frowned ferociously. "We must duplicate it somehow or the microzoöids wil die."

"Sarai ought to publish," added Quark indignantly. "Publish her methods, like everyone else."

"The medium must be based on their host organism," said Khral. "Station—can you do a cross check with the composition of all known Prokaryon organisms?"

Station paused. "It's done," she replied. "The composition is mixed, I'm afraid. Its pseudoproteins and other components are largely phycoid, although zoöid components occur too. Sarai must have used several sources for her broth."

"Or tissue culture," said Khral. "I'll bet anything she actually grows in live host tissues."

Phycoid and zoöid, thought Rod. He said, "Aren't tumblerounds considered halfway phycoid and zoöid?"

At that Khral looked up with a distant expression. "Yes . . . Did you check, Station?"

"My database has little on them."

Quark explained, "Hardly anybody's studied tumblerounds. They don't fit the neat categories; and besides, their 'glue' messes up nanoplast."

"It's worth a try," Station admitted. "Khral, if you and Quark can get a tissue sample up here, we might just set up cultures before these microzoöids give out."

That evening Rod called the Spirit Colony with his good news about Gaea. Mother Artemis was thrilled to see the toddler running across the holostage.

"Shall I keep her with me up here at Station?" Rod asked. "It will mean one less for you and Geode to handle." He could hardly bear to part with her again.

"As you wish," said Mother Artemis. "But we really want you all home as soon as possible. Haemum found a new medical service on the network, serving remote colonies all over Prokaryon."

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Haemum stood beside her, looking more grownup than ever. Her dark eyes were wide with excitement. "I'm learning to be a doctor, Brother Rod. I place my hands into those of the doctor on the holostage. I helped diagnose Chae's rash, and I held the otoscope in T'kun's ear."

"Why, that's wonderful." A bit much responsibility for their oldest daughter.

"Brother Rod, I think the network doctors should evaluate you, and 'jum, too."

He collected himself. Lifeshaping was more than an earache. "That's all right, Haemum; Station just gave us our checkups. 'jum needs to stay another year."

"But you can get a second opinion."

A second opinion? He exchanged a look with Mother Artemis. They had never sought any opinion outside of Station.

"There's no harm in trying," said Mother Artemis, "if Station consents."

Station allowed them the use of her facilities, observing only that the doctor on the holostage came from her own factory, a rather junior colleague. Haemum came up to help.

On the holostage, the "doctor" appeared as a disembodied pair of white gloves that pointed directions while its "voice" activated the body scanner. Haemum put her hands into the white gloves to show 'jum how to stand before the scanner. Then she set the conduits for nanoservos to enter her neck. Millions of the microscopic machines would swarm through 'jum's veins, reaching every pore of her body, testing immune response, liver function, and countless other things. 'jum bore the tests with sullen fortitude, as she did any activity that removed her from her precious numbers.

"The child is finished," the doctor announced at last. "The Valan-born adult, next."

So it was Rod's turn for the scanner, the nanoservos racing through his tissues. He tensed despite himself, and was surprised to feel nothing.

Haemum said, "The nanoservos are nonantigenic; that is, their materials are designed to trigger no immune response at all. So your body doesn't even know they're there. Isn't that something?"

"It's something, all right. And you've done well, Sister."

Her face darkened at the title. Rod realized that her eyes were nearly to his; she had reached adult height. Her curls twined in sophisticated patterns, a style never seen at the colony. Rod remembered what that age felt like, not so long ago, the feeling of a bird in a cage. "Do you know, Haemum, that you are a citizen of the Fold? When you come of age you are free to go—anywhere in the Fold."

Haemum's eyes took on a faraway look. "Yes, Brother Rod. But I will never go. I will make my vows to the Spirit when I come of age, just like you."

The doctor announced, "The adult is finished. Allow five to ten minutes for processing."

While they waited, Rod thought of something. "How is your service financed?"

"You are half through your trial pe-

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riod. If you choose to continue, we'll negotiate terms."

So that was it; he figured it was too good to be true. "Haemum, you might as well have all the children scanned for everything before our trial period runs out."

"Of course, Brother Rod. But surely we can continue somehow. We could raise our sapphire output; and there are crafts we could sell better, I know what Elysians like to buy . . ."

Though he knew better, Rod smiled.

"The child," announced the doctor, "has 80 percent chance of surviving on Prokaryon with no ill effect. She should sleep in a filtered room for her first year, and consume only processed food. If respiratory or dietary problems occur, immediate removal from the planet is indicated."

Rod was surprised. What would Station say to that?

"The adult should be able to eat some Prokaryan foods." The doctor meant himself, Rod realized. "Phycoid crops are recommended. Avoid hydroids and phycozoöids."

"See, Brother Rod!" exclaimed Haemum. "This doctor says 'jum can go home, and you can start eating brokenhearts."

"We'll see. What does Station think?"

"My guidelines are more conservative," came Station's booming voice. "Of course, most protection kicks in during the first few months of lifeshaping. But the remaining 20 percent can take years."

The disembodied white hands crossed each other. "Nevertheless, Colleague, most lifeshaped children make that adjustment on their own."

"You're correct," said Station in the tone of one applauding a young student. "But when reversal *does* occur, you are surely aware that the corrective treatment is far more expensive than if the patient had stayed in my care. The Fold instructs me to minimize expenses."

Rod wondered how to decide. "If we—if the Reverend Mother, that is—calls 'jum home, may she go?"

"She may go at any time," said Station. "For that matter, you may eat whatever you see fit. But when you get sick, your expenses may cancel your quota."

That was true; but with 'jum here at the clinic for a year, they would lose their quota in any case. Should they trust the new doctor over Station? What would Patella have done?

The Reverend Mother meditated for three days before her decision. At last she said, "The Spirit calls 'jum home."

So they ordered the filter unit for 'jum's room, then Rod packed up his few things and laid out 'jum's best red and yellow tunic. The lab students surprised him with a farewell dinner. Quark's eyespeaker came on Khral's shoulder, and Elk Moon came with his mate, Three Crows, who had looked after 'jum several times. He had just recovered from his illness.

Elk was laughing as the table extended for him. "You see," he told his mate with a pat on the back, "you just didn't want to miss the party."

"That is *not* true!" exclaimed Three Crows. "You just see how you like

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vomiting for three days. I broke my perfect attendance record."

"Not a sick day on board for over five years," Elk agreed. "Isn't it funny, though, how it started the minute you set foot in the starship? Otherwise you'd be gone now."

Quark put in, "This subject is inappropriate for humans at dinner."

Three Crows rolled his eyes. "Look who's telling us to be human. Anyhow, I'll miss 'jum. We've had some good times together, haven't we, 'jum?"

'jum snuggled closer to Rod and dug her hands in her pockets. Gaea held up her arms. "Good times! Go play with zoöids again."

Khral looked up. "They really love you, Rod. You must be a good dad."

Rod did not answer, but he felt warm inside.

"And besides," Three Crows added, "what a good aim that 'jum's got, hasn't she!" At that he and Elk collapsed laughing. Rod wished Three Crows had told him how the girl behaved. If she reverted to old habits, she needed correction.

"We'll really miss you in the field," Khral told him.

"Absolutely," said Elk.

"How are Sarai's microzoöids doing?" Rod asked. "Are they growing in culture?"

Suddenly the researchers grew silent. Elk looked away.

"They're growing," said Khral guardedly. "Their long generation time is a problem." Her reticence surprised Rod. She switched on the tabletop holostage.

"A controversial motion comes up before the Fold Secretariat this week." The great arch of the Secretariat appeared, where representatives gathered from all the worlds of the Free Fold. "The measure provides for cleansing of territories on undeveloped worlds, like the mountaintops of Urulan. The motion enjoys strong support from the governments of Valedon, Bronze Sky, and L'li; Elysium remains undecided. Opponents call the measure 'partial terraforming'; advocates call this term misleading. To voice your view, call in now. . . ."

Khral said wearily, "We know, we all called in already."

"Yes," said Three Crows, "I know how all you scientists vote, but I'd like to know what our Spirit Caller thinks of it. What do you say, Rod: Wouldn't it help your colony, to cleanse a bit of ground for human crops?"

Rod had mixed feelings. The idea had come up before. Distasteful as it was, it could save the lives of starving L'liites—those who had crashed would have had somewhere to go. "It might help others," he explained, "but not us. Members of our order worship the Spirit of the land, wherever we dwell."

"Then think well." Elk spoke quietly in his deep voice, still looking away. "In the end, how much land may be left?"

"Things come to pass," said Rod. "In the end, destroyers destroy themselves; but the Spirit dwells on." That was the central insight Rod had experienced, in his last year at the Guard, the first time he heard the Reverend Mother Artemis.

A new presence filled the little

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holostage: the President of Bank Helicon, Iras Letheshon, whose soul Rod had prayed for. A blond Elysian, she reminded Rod of the Sardish cadets he had dated at the Academy. "The rumors are unfounded," the doll-sized figure was telling the pair of snake eggs that hovered before her. "Terraforming is impossible—it would sunder the union of the Fold. How could Bank Helicon finance any such thing?"

"But our sources say you've advanced Proteus ten billion credits to buy up Prokaryan land," insisted the snake egg. "Land uninhabitable by humans."

"That's incorrect." Iras Letheshon spoke with the assurance of one enriched by several centuries and looking forward to several more.

"You've all but closed the deal with Nibur." Nibur, the head of Proteus, who invented sentient-proof servos and had just bought the house of Hyalite. Rod heard Quark restrain a hiss.

Iras shrugged. "Investors take risks and bet on new technologies. Proteus has developed means to cleanse limited tracts of land, without changing the whole biosphere. Clearing land is something humans have done since they first evolved."

Khral was staring, her fork suspended. "Look at her," she sighed. "Age, wealth, and all her looks, too."

Three Crows nodded. "Is life fair, or what?"

Rod watched the Elysian coolly. He could imagine what follies would tempt a soul possessed of such worldly riches. The cadets at the Academy—he had known well how to please them. But then, he knew only emptiness.

The holostage turned black. Amid the blackness shone a few faint stars. There hung a pale sphere of a starship, its well-known logo rotating in: a wave on the ocean, cresting and rolling forever toward the shore.

"Proteus." Quark spat the word. "It's Proteus—the flagship of Proteus Unlimited. Why'd they bother? Nibur never lets a snake egg inside."

Proteus. The spaceship the size of a moon, at your beck and call.

"As usual," began the holostage, "we have no direct comment from Proteus headquarters, but our sources say—"

"Come on, Elk," called Quark. "That scan of luminescence proteins must be done now; we want to get it read."

Elk reached his long arm across Khral's shoulder and transferred Quark's eyespeaker to his own. Three Crows touched the table, and his dishes descended. They wished Rod well and left. Khral however remained, toying with her food.

Rod ate more slowly, trying to savor the last taste of shepherd's pie he would get for a long while. For a moment he closed his eyes. When he opened them, he found Khral regarding him curiously. "What's it like, Rod? I mean, to be a Spirit Caller."

His fork stopped above his nearly empty plate. For some reason his pulse raced, as though he though she might see into him, into places he scarcely dared look. "We call on the Spirit, forever. The Spirit calls on us to serve life

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throughout the universe, in even the smallest and meanest corner of it."

"You mean, here?"

"Here and everywhere. Wherever life cries out for help."

"It sounds like a lot of hard work. You wouldn't even have time for a family of your own."

"But the family is my own." He tried to explain. "Each of us devotes his love to the Spirit, with a vow as sacred as marriage."

"I see." She sighed. "Scientists are like that, too; no time for families, only experiments."

Rod had something on his mind to ask. "You know, if you really could use my help with experiments in the field . . ."

"Yes?"

"I might still get an hour off now and then, to help collect samples." The rate of pay had impressed him. The colony could use extra credits.

Khral's face brightened considerably. "Oh would you? I mean, yes, the more hands the better. In fact, our field strategy is changing a bit. You might be interested to know . . ." She stopped. "Say—you're going down on that old lightcraft tomorrow, right? You could use help managing those children, I'm sure. Let me come down with you. Don't say no; I'll meet you at the gate in the morning."

Chapter 8

Deep in the void sailed the shoreless blue ocean world, whom the Sharer natives called Shora. All planets please the eye, be their continents habitable or cloaked in poison gas; but to Elysians in their floating cities, Shora was the most beautiful of all, the home of eternal life and peace.

Yet some Elysian citizens chose to dwell outside the floating cities. Some found the cities claustrophobic and everyone's business entirely too public.

In orbit above the ocean floated *Proteus*, the starship headquarters of Proteus Unlimited, the citadel of citizen Nibur Letheshon. Despite its size and complexity, *Proteus* was not sentient; it was a "stable servo." To remain "stable," *Proteus* was retrained every hour, its networks cleansed of the telltale signs of imminent sentience. A century earlier, its creator Nibur Letheshon had fought hard through the courts of the Fold to find this practice legal. His critics likened it to abortion, or even infanticide; for it was the law that any machine who "woke up" and named itself must be allowed to buy its freedom. But Nibur had won. Thereafter, he had steadily built one of the largest commercial empires in the Fold.

Inside *Proteus*, Nibur strode along an ocean beach that stretched to the far horizon. A man of slim bones and impenetrable eyes, he was clothed in virtual light, shifting shapes of black and silver that draped from his shoulders and stretched in a train several paces behind him. The air temperature and moisture were set to his perfect comfort. The scenery displayed one of a hundred shifting possibilities. Today was his favorite, a shoreline with a narrow beach before rocky cliffs against which the surf reared and thundered. The cliffs opened out in jagged formations, intriguing enough to pique the intellect. Wind

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perfectly massaged his forehead, the salt air filled his lungs, and the gulls cried pleasingly overhead.

As Nibur Letheshon walked the beach a dozen holographic callers impinged on him, managing sales, buying up resources, creating new products, from skinsuits to prefabricated cities. The holographic callers might have appeared as disembodied heads, revolving around him like moons. But today for his amusement he had them as walruses splayed out lazily on the sand, their wrinkled mouths yawning foolishly as they lifted their ponderous arching tusks.

"Bronze Sky wants fifty more orbital microwave stations. . . . Can we manage?" groaned one walrus, lumbering after him. The voice actually came through the nanoservos in his brain.

". . . a new market for stable servos in housing . . ." another walrus groaned in his brain.

All the questions Nibur answered, making decision after decision. Presently his eye fixed upon the one other fleshly object inside his complex: his golden-haired dog, Banga.

The dog, a retriever, had run on ahead as usual, his ears fluttering, his paws splashing in the surf. Now he returned, his tail waving like a flag. Banga always returned; had always returned to his master, for the past five centuries. Nibur, himself ageless, had had Banga lifeshaped before birth to be ageless like his master.

As the dog returned, panting, he hung back just a bit, dancing once around his tail, before returning to Nibur's hand at his diamond-studded collar. Nibur gripped the collar hard, his hand sunk into the dog's smooth fur. Banga might tease now and then, but always he would return, unconditionally, even if Nibur were to slit his throat. The creature lived or died at his pleasure.

But now, Nibur dreamed of a far greater creature to call his own: a planet. Iota Pavonis Three, so-called Prokaryon, would be his ultimate prize. A world full of life to live or die at his pleasure; the thought made him lightheaded. He released Banga's collar, his hands trembling with excitement at his dream.

A flat, clear voice spoke in his brain, the voice of *Proteus*. "Your two visitors seek entrance, Master."

So they had come—the two most powerful citizens of the Fold. He had called them to his citadel, and both had come. Would they play the part he planned in his grand design? Nibur whispered, "Bid them enter."

Above the walrus-tracked sand, a black rectangle appeared, disembodied, a door into *Proteus*. Through the door first came Iras Letheshon, President of Bank Helicon, the foremost lending institution in the Fold. Bank Helicon would underwrite his acquisition of the Spirilla continent of Prokaryon—once Iras said the word.

The butterflies of Iras' talar sported red and gold eyespots, matched by the reddened gold of her hair. Iras was by most accounts the most beautiful as well as the wealthiest citizen of Elysium. Her train of butterflies followed her talar, "real" material, of silky nanoplast just intelligent enough to swirl itself out of the way as the wearer

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walked. The train lengthened through the black doorway as she stepped along the beach toward Nibur.

The warm colors of Iras's train mingled with the foam and green flotsam that rushed over it behind her. She walked briskly, her muscles steeled by centuries of training in Bronze Skyan martial arts. She raised her hands. "Shonsib, it's been so long." Iras had shared Nibur's *shon* of Letheon, one of Elysium's twelve floating cities. Each city had its *shon* where all the children were conceived and brought to term in artificial wombs. They never knew biological parents, their chromosomes obtained from the best genetic stock throughout the Fold. "We should do business more often."

"Indeed we shall."

Iras turned, looking back toward her companion, who had paused deliberately at the black doorway. Iras's lovemate was Verid Anaeashon, the Secretary of the Free Fold. The secretary, too, had come at his call today. Nibur's lips parted, and his teeth slightly showed, as he watched the black door.

The secretary was short of stature, even for an Elysian. She descended with measured reluctant steps. Her talar was mottled brown with anaeans, leafwing butterflies. Her leaf-brown train followed, equally reluctant, swishing gently next to Iras's. Verid was as unlike her lovemate as could be imagined, in appearance, taste, and manner; yet Iras was her one weakness in this world. Nibur recalled with an smile some of Iras's more outrageous gifts to her love; diamonds too large to lift, let alone to be worn; or palaces full of virtual houris. Then his smile faded. Lovers or not, Verid would not give in easily.

"Greetings, Honorable Secretary," said Nibur with a deep bow. "The honor of your presence is most welcome." That she came at all meant Iras had made up her mind.

Verid's owlish eyes looked neither right nor left, but directly faced him. "I request introduction to your home." The secretary, the most powerful human in the Fold, was obsessed with those so-called sentient machines. She even gave them a delegate to the Fold Council. An abomination, Nibur thought. Why grant any of man's creations a pretense of equality?

"It's an exquisite device," said Iras, catching some "water" to dribble through her fingers. A huge wave rolled in, washed over the two visitors and thundered up the beach. Iras laughed in delight, while Verid stood like a dock post. "Really, Shonsib," exclaimed Iras, "you've outdone yourself." Iras's talar now drifted up slightly in the surf, though her hair was untouched. A connoisseur of virtual worlds, Iras was hard to impress. One of the walruses lumbered over to her next, bellowing and lifting its huge tusks, until she patted it on the head. Then she caught sight of Banga. "Say, you're cheating. That dog is real."

Banga had returned, his paws spreading sheets of spray around him. Nibur smiled and nodded, too proud to ask how she knew.

"Its fur was dry," Iras explained. "Congratulations, Shonsib, on your latest acquisition."

"Hyalite is just the beginning."

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Nibur rubbed Banga's head between the ears. "We must own the entire continent of Spirilla."

"So you've said. There are the practical questions, of course: Is Proteus Unlimited truly ready to meet the terms proposed, sustaining payments over two centuries? Is the transaction in our best interest? How will it affect the value of other Elysian holdings on Prokaryon?"

"Is there is a better credit risk in the whole Fold than Proteus Unlimited? Let your own servos calculate."

"Would I have come, had they not? Let's get to the point, Shonsib. What will you do with Spirilla once you've got it?"

Nibur shrugged. "My firm is maturing. It's time to diversify."

Verid gave him a sharp look. They both knew well enough what he intended

"Diversify?" echoed Iras. "Farming and mining?"

"Farming, yes. You must admit," said Nibur, "that we need better ways to settle Iota Pavonis Three." He always preferred the planet's original designation instead of its common name, sentimental in its reference to its living creatures. After all, life never occupied more than the outer scum of a world. Better to name a planet for its major features and its greatest resources—say, Planet Lanthanide. "Yes, better ways to colonize. The latest news from that deadly planet makes it clear."

Iras shuddered delicately. "A tragedy."

"But isn't the real tragedy that honest immigrants cannot live there?"

"There are settlements. Lifeshaped settlements," added Iras, with a look at Verid, the great advocate of lifeshaping human settlers.

"You can't call them real settlements," Nibur pointed out. "Not until the settlers start giving birth." No colonist had yet borne a child live on Prokaryon; the chemistry of development was too delicate. Even those lifeshaped from birth had to travel offworld to carry an infant to term. There was no such thing as a native Prokaryan.

"Not yet," agreed Iras, "though in a generation or two—"

"They'll get it right some day—at what cost? Do you know how much it costs now to lifeshape every one of them, even the babies? And then to manage their pregnancies later? No more than a handful of L'liites will ever settle there."

"It's true," said Verid suddenly. "That is what science is for. Our scientists work day and night to solve these problems."

Privately Nibur did not care much about L'liites. They would be better off today had the creeping pruned their numbers several centuries before, for fewer people would be left, with less irreparable damage to their biosphere. But Iras had a soft spot for L'liites, along with guilt at having made her fortune on their loans. Nibur lowered his voice. "What harm is there in cleansing just a part of Pavonis Three—a continent, let us say."

Iras paused, not looking at Verid. "A lot of L'liites could live there. The native species would have three other continents, plus the ocean."

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"The native flora of Pavonis Three are remarkably uniform," Nibur pointed out. "The Spirilla continent, for example, supports only a thousand major species, all found elsewhere on Iota Pavonis Three. The few exceptions will be transplanted."

"The weather, too, is remarkably uniform," added Iras. "Our tests show that the ocean will buffer the other continents, which will not experience severe effects."

"Hundreds of millions of settlers could lease farm land," said Nibur. "Mining productivity could rise ten or a hundred fold."

"In fact, the value of all of our holdings anywhere on the planet will shoot straight up."

"Iras," said Verid quietly.

Iras tossed her head and took a deep breath. "You know, I can't leave your creation without exploring a bit down the 'shore.' If you'll excuse me, Shonsib . . . " She swirled her train around in a wide arc through the waters and strolled outward, leaning over to inspect a shell or a bit of seaweed.

Nibur took a step toward Verid, the black light shimmering down his talar. Verid watched him, her shoulders slightly hunched, her eyes wide, thoughtful. "'Transplanted,'" she repeated.

"We'll hire all the best eco-engineers." She must know she lacked the votes, he told himself, or she would not have deigned to come. She must know she could not stop him—and her own lovesharer would finance it. The triumph was too sweet.

Still, never underestimate the Owl. If a way could be found to stall him, she would find it. What would be her move?

"The weather is uniform," mused Verid, as if to herself. "The planet is indeed well managed."

With a shrug Nibur picked up a stick of driftwood and tossed it to Banga. "The Honorable Secretary herself signed the declaration that Pavonis lacks intelligent native life."

"'Intelligent life.' You mean, fast-talking bipeds with ten fingers."

What was she getting at, he wondered. Could she really try to resurrect all those "alien intelligence" rumors? "Ten fingers would help," he said ironically. "At least they could make sign language."

"There once was a great creature that dwelt in the deep, its ten fingers each longer than ten men stretched on end. Where lies that creature now?"

"Surely the secretary will not call me to task for a dead creature on a world long gone? Every world has its share of extinctions. Even your blessed Sharers caused mass extinctions."

"It is said, no life exists outside the Web."

"No life escapes death, either." Nibur looked down at the foot of her talar. "Watch out there."

A jellyfish with its poison tendrils had washed onto her hem. She shook it off, forgetting the illusion.

Nibur gave a low chuckle. "So much for nature's creatures. Look—" He spread his arms. "I enjoy nature as much as anyone. But what difference does it make to us whether a dead creature exists or not, on a world many light-years away?"

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"You play with your toys," she said with anger.

"Honorable Secretary, excuse me," he said, bowing again. "We are considering a proposal to settle millions of starving L'liites on a free world. Humans with vital needs—and souls, remember. We Elysians needn't worry to keep body and soul together. How dare we put the needs of some mythical creature above our own humankind?"

Verid moved closer to him, until her small round face was staring up into his own, uncomfortably near. "You don't care about humankind. You only want to own that planet. You will buy and kill, until you've got it."

Nibur's mind raced. How could she know of his secret agreements? Of course not; but she would guess. Elysians knew each other only too well, after centuries spent outwitting each other.

"What will you do with it?" she demanded. "What will you do once you've got it?"

"Now, now. Trade secrets, remember." He paused. What could it matter; she knew what he wanted. "My creations require materials. The history of man is the ascent of machines; the rise of ever greater devices to serve our desire."

"The history of man is the contest between the enslavers and those who set free."

"Precisely. And I set men free—free from the limits of their flesh."

"By enslaving 'the other.' So what if their flesh is nanoplast?"

"By applying our intellect to inanimate objects."

Verid shrugged. "Different words."

Nibur paused. "Did it ever occur to you, that with the capabilities *we* provide them, our devices could become *our* masters? If machines are human, then we humans are finished, because the machine has no physical limits."

"Life is more than physical limits. There is . . . humanity."

"I offer humanity the choice: Let machines be machines. If machines are our tools, nothing more, then humans are unlimited."

"A choice, you say? And what gives *you* the right to that choice?"

Nibur lost patience. "Why ask me? Why not ask the universe what gives it the right to throw an asteroid at a living world every hundred million years? The last one that hit Pavonis killed all but the microbes," he said with contempt. "Why shouldn't humans use a world as we choose? Are we not worth more than an asteroid?"

"Are we?" Above her head the gulls circled with their cries, and the sea breeze keened. Then abruptly she turned and left, disappearing through the black doorway, her train shrinking down to nothing.

Chapter 9

As promised, Khral met them in the morning at the brainless old lightcraft. Rod carried Gaea into the craft, while Khral carried one of the travel bags, with 'jum holding her hand. He winced to see the battered console; somehow it looked even worse, with another adult to see it. As the hatch closed behind them, he hoped the craft would not treat his guest too badly.

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Above the holostage, the hull of Station receded into darkness.

"This is the only place I could talk," Khral said suddenly. "Station told us to shut up, lest reporters hear. And Station hears everything." She shuddered. "Rod, those microzoöids grew alright—slowly, but they're growing, even 'triplicating' now and then. And yes, they flash prime numbers."

"So Sarai was right."

"Yes."

"But that's great, isn't it? Now you can grow the ones from the singing-trees, and decode them somehow."

"Rod—these microzoöids are different. They're a different species altogether from the ones in the singing-trees. You see, now? *Where do they come from?*"

He frowned, puzzled. Then he remembered. "They grow . . . in tumbleround tissue."

"Now you see why our field work will change."

For a moment his skin crawled. Then he relaxed. "So be it. Tumblerounds are no strangers to us; I'd still be glad to help out. But why not let the reporters hear?"

"Station says all hell would break loose. Half the reporters would condemn us for trying to influence the vote in the Secretariat—to quash the 'partial terraforming,' so that Iras can't make the deal with Nibur. The other half would descend on Prokaryon—and the tumblerounds are unpredictable, not studied for years like the singing-trees."

Politics again. Rod shook his head. "You can't hide the truth."

"I know, but . . ." Khral bit her lip. "We were so sure about the singing-trees. Now, who will believe us about tumblerounds? We need better data."

The craft was coming in faster than usual, Rod thought, and the scream of the plasma sounded uneven. On the holostage, he saw with alarm that they were headed ominously near the end of the brokenhearts, where the field met the forest.

As they approached the ground, the floor swayed up and down beneath their feet. Gaea laughed at first, then started to shriek as the craft swayed harder. With one final jolt the craft landed, at a crazy angle up against a singing-tree.

No one was hurt, but the door half faced the tree. It took all Rod's strength to force it open; then he had to jump down to the ground outside. Khral handed each of the children down, first screaming Gaea, then stoical 'jum. Then at last Rod helped her jump down. "I'm so sorry," he said. "I don't think that craft will make it back up again."

"No problem; Quark will fetch me up." She glanced frankly at the craft, then at him. "Take care of those children, Brother Rod."

So this was the Children Star, thought 'jum. Brother Rod was still her god of death and life; but like most gods, he did not keep all his promises. He had promised no more sickness; yet day after day she had been sick to her stomach from all the strange potions of the machines in this prison-palace, where unheard-of riches combined with unending tortures. She still dreamt at night of her

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mother, whole and well, come to fetch her home again. But lately the dreams had dulled, and sometimes she could not remember what her mother looked like.

The only family 'jum had left was the family of numbers. The prison-palace offered numbers and patterns of numbers beyond imagining. Lately 'jum had learned something called a transform that could turn the patterns inside out. On the lightcraft, while Brother Rod was preoccupied, 'jum had tried to talk to the holostage. "Show me the transform of four dots in a square," she had demanded. This lightcraft did not answer, however; it was as stupid as most people. So 'jum crossed her eyes and thought out the transform for herself. It would have concentric circles of light, tiled with little squares.

When the door opened at last, 'jum fell out into another world. This world had a fresh, fragrant smell to it, almost like the old days when her mother had a kitchen to bake in. Something wet trickled down her cheek; she wiped it off hastily and dug her fists deep into her pockets.

The bright light made her squint at first. But then, the loopleaves and whirling birds and distant forests, all came alive—*alive*, not just shapes of light on a holostage. Real earth, full of things to catch your feet. Brother Rod was running ahead to pick up little Gaea, who already had fallen over herself. With his back turned, 'jum's pockets soon filled with pebbles.

In the distance two great beasts came lumbering up a trail, their ears sticking out straight as street signs. They looked like llamas, with ridiculously outsized hooves. An older girl called Haemum stepped down from one of them, crying out to Brother Rod. Like Mother Artemis, Haemum spoke 'jum's language with an odd accent, but 'jum could understand most of it. Some great creature was looking in at a window, Haemum said.

"'jum, you can swing up behind Haemum," said Brother Rod. Reluctantly she did so, keeping a wary eye upon her god while he swung the little one up with him on his own mount. But Haemum had a strong back and rode well.

They came at last to a building, a long structure built of what looked like some kind of animal dung. The animal dung was draped with festive decorations. A large banner had on it some words in the new letters 'jum had been learning; it said, "Welcome home. . . ."

Brother Rod leaned over to hug her. "It's your own name, 'jum. You remember."

She stared curiously at the letters that meant her own name. Then suddenly, strange children came streaming out, all kinds and shapes of children. Some of them looked familiar from the holostage; but that was quite a different matter, 'jum had learned. In the flesh, too many children meant trouble.

But then came Mother Artemis with all the stories on her skirt. The skirts spread, and there leaped a mountain goat just like the ones that scampered up the cliffs of Scarecrow Hill. Immersed in the story, 'jum forgot all about the extra children.

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Suddenly she realized—where was Brother Rod? She never let him out of her sight, if she could help it.

"'jum Ghana," Mother Artemis was calling. "Do you understand me? This is your brother Chae, and your brother T'kun. And here, your little sister . . ." She went on naming all the little faces with stupid fingers in their mouths. But 'jum was too confused to hear them. The two boys stood there, like two bright dots. She crossed her eyes; the transform was simple, many bright bars spread evenly across a disk.

"Hey, what's she doing with her eyes?" Squeals of laughter followed.

'jum looked up at Mother Artemis. "Where is Brother Rod?"

The snakes of Mother Artemis's "hair" swept up to point like a weather vane. 'jum followed her out around the dung house to a garden. A huge round creature slouched there, near a window, and Brother Rod was trying to help Haemum dig it out. The creature stank worse than the city streets in summertime. Creature or tree, or moldering truck tire—whatever it was, it was certainly the most bizarre sight she could remember, with clouds of insects surrounding it, alighting and flitting up off it again like the many lightcraft above Reyo. 'jum stood and watched as Brother Rod and Haemum hoisted the thing onto a cart and drove it off.

Now her god was gone—and Mother Artemis was unaccountably gone too. 'jum was all alone, among the children.

"Where you from?"

"Come on, 'jum; you're my friend."

"No she's not, she's a—"

'jum froze, withdrawing into herself. She could see the children, but she did not let herself hear their talk, or their nervous giggles. There were two of them, and one behind, and two more beyond the one. Two triangles with one dot shared—what an interesting pattern.

Someone shoved her on the arm, then ran back giggling to the group. 'jum knew that they were laughing at her, and that they expected some kind of response. But she never knew any response that helped. Warily she closed her fist around a pebble in her pocket.

Another child came forward and shoved her harder, grabbing a fistful of her shirt so that she nearly fell. That was the worst thing, you learned in the streets of Reyo: Never fall down, because the crowd will never let you up.

The one who had grabbed her, called T'kun, rushed back to the group amid laughter and scolding. 'jum stared hard at him and focused her aim. Her hand whipped from her pocket, and the stone leaped out to meet him exactly between the legs.

T'kun screamed and doubled over. The children scattered, except for an older boy who helped T'kun away, bawling his head off. Now 'jum was truly alone, with no companion save the countless rays of a foreign star.

The cart with its ponderous load creaked perilously behind the spitting llamas. Rod and Haemum pushed from behind, careful to avoid the llamas' aim. Haemum shook her head. "I

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don't know why this tumbleround keeps coming back. We never used to get tumblerounds."

Rod said dryly, "The Spirit sends strange messengers." He wondered about Khral's microzoöids. Was it just another false alarm? On the horizon the enigmatic singing-trees formed a dark band edged with light.

"Pomu had a whirr caught in his eye yesterday," added Haemum. "I found it, and used the correct procedure to wash it out. I confirmed that baby L'lan has a dislocated hip; but I think we can treat that here."

Rod nodded. Three weeks left of their "trial period."

Haemum suddenly stopped and threw her arm around him with such a strong hug that he nearly lost his balance. "I'm so glad you're home again, Brother Rod. You always set things right."

After a good hour's trek, Rod hoped they had taken the beast far enough. Carefully they tipped the cart on its side and hauled the tumbleround out, taking care not to scrape it too badly. Pain shot through Rod's back as he tried to ease himself up. Watching the great phycozoöid, he was struck with a sense of absurdity. "You know, Haemum, that thing is our 'master.' Khral thinks so." And here they were again, dumping it out like trash.

"Is it really?" Haemum gave a puzzled look at the stinking mess as it oozed into the loopleaves. "It never says a word."

"It sends microzoöids. Thank the Spirit they can't grow in us."

She still seemed unconvinced. "Why would any intelligent thing let all those vermin buzz around it? Wouldn't it invent bug pills?"

His eyes suddenly focused on the whirrs. For a moment he froze, seeing nothing else but that cloud of tiny helicoids. Insects carried disease, didn't they? In this case, might they carry messengers? He wondered what Khral would think.

As the two colonists returned tothe compound, Chae came running out to them, his starstone bouncing around his neck. "Brother Rod, that new girl is in trouble."

Geode told him the story. "She's up to her old tricks again," the sentient exclaimed, waving two limbs. His other arms carried two of the babies from Reyo, both filling out wonderfully.

Rod found 'jum in her room, a small compartment partitioned off the row of beds where the other children slept. 'jum sat on her bed quietly, while the air filter gently hissed behind her. Her cheeks had filled out, but her expression held the same sullen stare that Rod remembered so well. "'jum, don't you remember? You can always call on me. You don't need to hurt people."

She looked away. Rod sighed. To her, this new planet must seem even stranger yet than Station, even with all the holo scenes she had viewed.

He picked her up and folded her in his arms, where she relaxed a little. "'jum, can you tell me something?" he asked after some thought. He sat with her on the bed and looked into her eyes. "Can you tell me what you would like most of all, in all the world?"

'jum's eyelids flickered. "I would like to count all the rays of the sun."

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The answer surprised Rod, who expected her to ask for her mother or her old home. But then, he should have figured. "All the sun's rays, 'jum? That's a tall order. The sun's rays are infinite."

"Infinite?" She turned toward him with interest.

"So many that no one can ever count them all, even you."

She looked down as if skeptical. "A transform can measure anything."

"You know, 'jum, other things are infinite, too. The love of the Spirit for you, and all of us—that love is infinite. We all want to share that love with you, 'jum." 'jum did not seem impressed. Rod sat back on the bed, thinking. "There are different kinds of . . . infinite numbers," he recalled vaguely from his calculus class at the Academy. "You could learn about them on the holostage."

"Really? Do we have the holostage here, too?"

So that was what she wanted. "Of course we do," he promised. "But remember the rules. Your brothers and sisters need to get to know you."

Rejoining the daily prayers renewed Rod's strength and took his mind off worries that swam deep as *Architeuthis*. Over the next few days he immersed himself in the field of brokenhearts, weeding between the rows of golden ringlets that shook and vibrated in the wind, listening to the hum of helicoids alighting to suck their juices. Then he checked the children's progress with their new lessons on the holo, and he sorted their finds from the sapphire mine.

"We found several blue-tinted ones, and one deep pink, two-point-three carats." Geode held up two infants to burp after feeding.

"Good work," said Rod. "But you know, if you count the time they spend sorting, I wonder if it pays off. I can earn more, working on Khral's project. The children should spend more time in school."

Geode twisted and untwisted a yellow limb. "I've never been able to understand why they can't make human children learn all they need in the first month of life. I would think doctors would have corrected that by now."

Sentients could not understand; their own thoughts ran so fast, they could live a thousand lives at once, along with the one they shared with humans. Rod looked at Geode curiously. "What do you do with all your free time? I mean, the part of your mind that's not watching children?"

"Well, sometimes I read literature with Feldspar. We've covered all the works of poetry of three planets. Feldspar has good taste, but some terribly wrong ideas—I do set him straight at times. But lately I've been too busy."

"Worrying?"

"Busy praying," said Geode simply. "This colony needs all the help the Spirit can give."

His lips parted, but there was nothing to say. He could imagine Mother Artemis, too, praying incessantly. No wonder sentients made such good Spirit Callers.

The next day Diorite came over, with another small package to "ship quick."

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"We're waiting to get the lightcraft fixed," Rod told the miner. They really needed to hire a sentient; they had been getting by on borrowed time. But they had no funds; even with Rod's wages from the field lab, it would take months to make a down payment. Somehow, the Spirit would provide. "We've got a nice load of crystals, though," Rod said. "Chae found one that's deep pink, nearly a ruby."

Diorite sighed. "Well, enjoy your luck while it lasts. You heard the news?"

"What news?"

"Proteus went and bought our whole continent, whirrs and all."

"Is it that bad for you?" Rod asked sympathetically.

Diorite leaned forward and slapped his knees. "Son, where've you *been?* I mean the *whole continent.* All the nonprofits, too. You've got a new landlord, didn't you know?"

Rod frowned. He knew that Mother Artemis was checking it out. "The Fold has been trying for some time to privatize colonial management. They think it will be more efficient. But who would want us? There's no profit in it."

"Exactly." Diorite shook his head ominously. "Whatever Nibur wants this continent for, it won't be good for you or us. He couldn't care about namestones." He paused reflectively. "I don't know, though. I wonder if old Nibur hasn't bought more than he paid for."

"What do you mean?"

"Did I ever tell you about the L'liites from the ship?"

"Did you find any?" Rod asked quickly.

"Only those killed in the crash. But we never found all the bodies. There were tracks leading into the singing-tree forest. And where the tracks ended—"

"What?"

Diorite's voice sank to a whisper. "They were covered by tumbleround tracks."

The next morning, as Rod was heading out to exercise the llamas, Geode called to him, waved his limbs excitedly. "Brother, come quick. Our new management is on the holo."

The three Spirit callers met at the holostage. Mother Artemis and Geode each had a cranky baby in hand; Rod hoped Haemum and Chae could manage the rest of them for now.

Above the holostage hovered a column of light. Within the light appeared an androgynous Elysian behind an imposing desk. Before the desk floated a house logo, an ocean wave rolling incessantly toward the shore.

"Greetings," said the Elysian. "I represent Proteus Unlimited, to whom the Fold has entrusted management of your Spirit Colony." The figure did not introduce itself personally. It probably was a virtual construct, not a real human or sentient. "We have a new plan to improve the quality of your operation. You will triple the yield of your staple crops and become a self-sustaining colony."

Rod wanted to hear more about the colony's rights and expectations under the new system. But the figure had other concerns.

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"We have identified a new site for agriculture," the figure continued drily, "on the south-east quadrant of Chiron." Chiron was another continent on the opposite side of the planet. "The Chiron site offers optimal growth conditions for native food crops—indeed, the best to be found anywhere on Iota Pavonis Three. All of the nonprofit colonies will relocate there. You will enjoy increased productivity, as well as new medical and scholastic opportunities provided by consolidation of colonial communities."

At first Rod could not comprehend what he was hearing. The ocean wave rolled on in silence, never crashing.

"Are there fields to hunt zoöids?" asked the Reverend Mother. "Is there a sapphire mine?"

"You will no longer require such sidelines. Your productivity and lifestyle will improve substantially, thanks to more efficient agriculture."

Rod found his voice. "We've invested two decades in this bit of land. Our charter lasts into the next century. We can't just be moved."

The figure did not even turn its head. "True, you have a charter. Until now, the Fold has overlooked your chronic abuses of your charter—removal of ethnic treasures, child labor, smuggling of lanthanide extractors, to name a few. You would be wise to cooperate with us, and start over with a clean slate."

Lanthanide extractors—was that what old Diorite had them carrying up to Station? As for the rest . . . Dazed, Rod shook his head.

"What will become of our rescue program?" asked Geode. "Will you sustain our immigrant quota?"

"The removal of ethnic treasures must cease." "Ethnic treasures" meant creeping-ridden orphans like 'jum; Rod had heard this nationalist line before. But why would the Fold suddenly accede to it? "Soon," the figure announced, "a new era will dawn in the settlement of Iota Pavonis Three."

The Proteus representative at last fell silent, as if expecting questions. But the colonists were left speechless.

"You have one month to settle your affairs; servos will help you pack for the move. Proteus Unlimited will cover all your costs, of course. Good day." The holostage went blank.

"The Reverend Father must hear of this!" exclaimed Geode. "No more settlers—impossible."

"That Diorite," grumbled Rod. "How could we have trusted him? Just when we need good credit, look where it puts us."

The Reverend Mother caught his arm. "Be careful. We don't yet know the truth."

"The rest is all false. How could Proteus expect to get away with this? The Fold must hear at once."

Mother Artemis shook her head sadly. "I wish it worked that way. But I fear the Fold already knows too well."

"But they can't—" Rod stopped himself. Shaking all over, he tried to collect his thoughts. Mother Artemis was probably right, he realized with horror. "But how could they do this without . . . public hearing? Consultation?" He thought of something. "What did he mean, a new dawn for settlement?"

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"There has been debate, in the Secretariat," Mother Artemis explained. "Elysium and Valedon want more settlements, fast, to keep the L'liites coming here, instead of there."

"They've always wanted that. So, why make us stop adding settlers?"

"I'm not sure," said Mother Artemis. "They've never really cared for us; our colony is too small and expensive."

"But how do *they* plan to settle? Our colony has always cost the least per settler, of all the colonies on Prokaryon. You don't suppose the cost of 'jum's lifeshaping—"

"No," said Mother Artemis firmly. "Whatever is going on, it's far bigger than 'jum, or all of us; our colony is but a speck in their eye."

Geode said, "We still must inform the Reverend Father of this outrage. At least they can let the world know."

"The Most Reverend Father will tell us to heed the Spirit, and obey worldly authorities." Mother Artemis sounded oddly hesitant. "And yet, the Spirit does not call me to address His Reverence just yet."

The very hint of a difference between Mother Artemis and the Most Reverend Father was unthinkable. Rod turned to her, astonished.

"So what shall we do?" asked Geode.

"Pray," said Mother Artemis. "Let us pray together until the next sunrise."

Chapter 10

At dinner Chae rolled out the steaming kettles full of brokenhearts. It was time at last for Rod to try to eat them. He spooned some of the pale rings onto his plate, where they rested limply. As he raised a spoon toward his lips, T'kun grabbed his arm. "No, Brother Rod; that's not your food!"

Rod smiled and rubbed the boy's head. "It's all right, T'kun. I can eat home cooking now." With a dozen pairs of eyes on him, now, he had to look brave. He took a spoonful and swallowed. The grains drenched his tongue with ginger, as well as less palatable tastes of things humans were never meant to consume.

"Excuse me," Rod said, rising from the table. "I have to help Gaea with her lessons before bed." The children all had lessons to finish, numbers to add and capitals of all the Fold's worlds to name. Pima and Pomu cried when it was time for their bath. All the while, Rod thought of how they were stuck without their lightcraft, and the colony faced extinction. He was not a sentient with multitasking capacity, and amidst such thoughts, it was hard to find room for prayer.

When the last infant was in bed, peace descended. From the sky the rain settled lightly as always, until the stars emerged cold and silent, and the red moon glowed. The Spirit Callers stood together and began their prayer.

"Spirit of all worlds, breath of all breaths," called the Reverend Mother, her hair tendrils stretching toward the stars. Beside her Brother Geode watched the sky with a rapt expression. "Help us to be strong in our darkest time. Let hope find us even in the deepest waters, like those glowing fish whose light shines forth over the ocean floor. Above all, send us a

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hundred times forgiveness for those who would do us harm. For their need of You must be a hundred times greater than our own."

Rod bent his head over his clenched hands. Forgiveness was one thing, but how could he forget? All of his children, to be uprooted yet again from the one real home they had known. Indeed, he thought, he would have to forgive a hundred times yet, before he could forget. But on and on they prayed, in voice and song and in stillness, until Rod lost track of time. At last, remembering his human need, the Reverend Mother sent him to sleep.

In the morning Brother Geode was up early as usual, bustling about with the babies, offering milk and cooing at baby Qumum. But Mother Artemis herself kept the vigil well past sunrise. She seemed to have entered another world, like a Sharer in white-trance.

As Rod helped the little ones pull their shirts on and tried to locate their starstones, Pima waddled over breathlessly to announce a visitor. Rod went to the door with Gaea clinging to his leg. Whatever could he do to save them, he wondered for the thousandth time.

There stood Diorite, his wiry arm tracing a starsign, the last person Rod wanted to see. Elysians were bad enough, but it cut deeply that a fellow Valan would let him down.

"It looks bad, Brother, mighty bad," Diorite solemnly intoned. "You know, we've got to have a plan to face this; we can't just roll over. We have to stick together—"

"Enough of your plans," said Rod coldly. "You've gotten us into enough trouble already."

"Trouble from *me?* I'm as bad off as you are."

He had to force the words past his disgust. "You smuggled lanthanide extractors." He did not even want Gaea to hear the words.

"Oh, no." The miner's face fell. "I did that only once, months ago. Nobody gets booked for that, anyhow. I've never sent anything that harmed anyone, no drugs or weapons. What else do they say I've done?"

Gaea reached insistently, and Rod finally picked her up. "It's no matter. We're through."

"Don't be hasty. Don't you want to know how in the Spirit's name they found out what we sent? Do you know how illegal *that* is?"

"Birds of a feather."

"And fools see only fool's gold!" Diorite took a deep breath. "Listen, Brother—if we're to beat this thing, we have to work together."

"You can tell the Reverend Mother." As soon as he spoke Rod felt ashamed, for he knew what she would say. His hand sketched a star sign. "It's forgotten," he murmured, his eyes averted. But he would never again carry the miner's cargo.

Diorite let out a long sigh. "Brother, there's only one thing that can save our homes—only one way to keep Spirilla out of their hands. You know that?" He leaned forward, hands on his knees. "The tumblerounds. You know that's who really runs this place, don't you? They kidnapped the L'liites—and we're going to track them down and prove it."

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Rod listened, no longer certain whether to believe him or not. "Well, you'd better find out soon. Proteus is wasting no time."

"We'd better find out, all right. Because if we don't, and Nibur goes ahead and boils off *their* home—there will be hell to pay."

His jaw fell. "Boil off? You don't mean—"

"That's just what I mean. Why do you think they're clearing us all out? They're going to 'cleanse' Spirilla."

"Terraform the continent? Impossible."

"Rumor has it they've already started, out on the western coast."

All the fields of brokenhearts, and the singing-tree forests, cooked into soup; all those living souls. Who could do such a thing? This Nibur Letheshon—what kind of person could he be?

From behind the compound came Mother Artemis, walking slowly as if still entranced.

"Excuse me," Rod murmured and hurried quickly to meet her. They held each other close.

Mother Artemis said quietly, "I know what we must do now."

"Yes?"

She waited for Brother Geode to join them. "First, we will put a one month appeal on Proteus's order. We have that right by law. It will be overruled, but it will buy us time."

Geode waved a red limb. "It is our right. Even the Reverend Father would agree."

"In the meantime—" Mother Artemis paused. "I will pay a call on my old friend, Verid."

Rod raised an eyebrow. "Verid Anaeashon? The Secretary of the Fold?"

"You will call her?" Geode exclaimed.

"I will visit her in person. She is not immune to the Spirit; she will hear our cry."

"I'm sure she will," said Geode. "Verid has known you forever—and she owes you one or two."

Perhaps there was hope after all. Rod felt a weight lift from his heart. But Mother Artemis leaving—that would be hard. "The children—they've never been without you."

"It will be the hardest thing I've ever done. I will need your prayers."

The Reverend Mother Artemis booked passage on the next starship scheduled to leave Station. Diorite sent his lightcraft to carry her up. The sight of the craft, signaling the Mother's imminent departure, threw everything into chaos as children wailed and collapsed right and left. It was all Rod could do to keep the littlest ones clear of the landing.

"Peridot here, at your service," called the craft. "I just earned my freedom. I got a salary in the ninetieth percentile."

"Congratulations," Rod called out. "And thanks—we're so much obliged."

T'kun fell down shrieking that his leg was broken, and Mother Artemis had to stay and fix it.

"By Torr," exclaimed the lightcraft, "I'd heard human babies keep one busy, but this is something else."

He watched the rising lightcraft until it was a bright speck in the sky

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that disappeared into the blue. At length he turned away, thinking, nothing left but to hope. Haemum and Chae pitched in right away with the younger ones, changing diapers and bandaging scraped knees. Rod tried not to think about whether they got their studies done that night.

The days that followed fell into a new routine. Geode led the prayers, and Haemum joined in the evenings. Harder than ever, they called on the Spirit to protect Prokaryon, and to help the Reverend Mother in her mission; and to open the ears of the Secretary of the Fold.

At times, though, Rod found himself wondering. He had always relied on Mother Artemis to plan for the future, just as the Reverend Father planned for her. Obedience in material things meant freedom of the spirit. He had never followed the politics of the Secretariat, let alone the various worlds of the Fold. Yet Mother Artemis kept track of events, and finally chose to act "in the world." When a great evil arose, the Spirit called for action.

By day there was less time to think, as everyone took on extra chores. A field needed sowing for brokenhearts; without Feldspar's help, they would never have managed. In the garden the tumbleround stayed away, but Rod noticed a couple of snake-egg reporters hovering near the roof. They never requested an interview, just hung there, eavesdropping. What sort of story were they after? It had been some time since their last "human interest" piece; afterward, the craft sales had increased a bit.

'jum did well physically, though she had to spend most of her time in the filtered room. She ate the same bland food pellets that Rod used to eat. Rod gave her daily time for math at the holostage, and Haemum taught her to make tourist dioramas. She took to it surprisingly well, pasting cuttout zoöids onto backdrops one after another, methodically, as if she were back in the Hyalite factory.

For his part, Rod tried to eat more brokenheart stew. His stomach held, but the taste still gagged him. He realized that all the food on Prokaryon had always smelled to him like glue or cleaning fluid, or other chemicals not meant to be eaten. But he had figured the lifeshaping treatments would change his taste buds as well as his liver. Now he might learn to eat Prokaryon food, but he would never enjoy it. He dreamed of shepherd's pie at the table in the Station lounge.

One night he dreamed of Khral. She was alone in the dark, wearing the protective skinsuit which made her glisten all over like a gem. But when he reached out to touch her, the nanoplast dissolved, and she fell into his arms. An indescribable joy flooded through him, as if he had waited a thousand years for a drink of water.

The dream was so vivid Rod awoke, sweating all over and distressed. He had felt little need of women since he joined the order. He had no strong feeling for Khral when they met at Station, though he enjoyed her friendship. She was nothing like the women

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he had before, who were tall and blond and could shoot as sharp as he did. Khral stood barely a meter and a half, with a simian stoop; she would not have met Academy standards. And yet, somehow . . . It was nothing, he thought, but he could not sleep again.

The next day three visitors appeared at the holostage. L'liite in appearance, they wore talars of brighter colors than usual, and their curls were dyed orange, piled into striking knots.

"We are the L'liite People's Federation," one announced. "We demand the repatriation of our citizens."

Rod glanced at Geode. Geode whispered, "It's *them*—the nationalists. What spirit brings them out here?"

"I don't know." Rod wished Mother Artemis were here to address them; she would find the right words. "Our colonists were adopted legally," he told the group. "We rescued them from certain death, and now—"

"Rescued?" the L'liite interrupted.

"You call that 'rescue'?" said another. "Abducting our ethnic treasures and putting them to work? Mining gemstones with child labor?"

The L'liite in red shook a fist at him. "You're covering for those lanthanide miners. That's why they run all your farming for you. You're a sham."

Rod nodded slightly. He could see their point. Entanglement with the world—and yet without it, their colony would have gone under, many times. "We do our best for the children. We raise them as free citizens."

"Free citizens? With less than two hours a day at school?" The L'liite sounded scandalized. "We know—we've been monitoring."

He took a deep breath. "What do you want of us?"

"You heard me," said their leader. "Let our people go."

"Our children?" For a moment Rod was hopeful. "Do you wish to adopt them?" Much as Rod loved the children, he could not deny them the chance of traditional parents. That was what 'jum really needed—her own mother and father, with infinite time to share.

"You're evading the issue. Give back our children—and close down your perverted operation. Children abducted to be raised by dimwits—imagine."

At that Rod froze. Better silence than what he would have said.

"It's true," said Geode earnestly, "we've made some mistakes. Won't you come meet the children in person, and see for yourselves if they're happy? Perhaps we can do better."

The L'liite gave the sentient a look of utter disgust. "You know we humans can't survive on your toxic world. Get out, and let the Fold clean it up."

"We'll stay on your holostage," warned the other one. "We're prepared for a hunger strike."

Rod bowed slightly and spread his hands. "Good day, Citizens." He turned quickly and left.

"So that's what the snake eggs were after," exclaimed Geode, outside. "I wonder how those L'liites shipped to Station so fast. I'll bet Nibur paid their fare."

"Peace, Brother," Rod warned, sketching a starsign. "The Spirit save them from their folly."

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"Yes, but what about our holostage? They got a free-speech permit to occupy it."

So the holostage was out of order for a day, then the next. No more school time at all, now, thought Rod. More of the snake eggs came hovering again, this time to ask what he thought of the witnessers, and how could he let them starve themselves.

By the week's end 'jum was in trouble again. "She was fine, so long as we left her at the holostage," Geode explained. "She behaved for a while, and seemed interested in sorting the crystals."

Haemum nodded. "I sewed up her pockets to keep her from hoarding them."

"That was clever." But Rod noticed the dark welts under Haemum's eyes. She worked herself too hard.

"'jum still keeps to herself too much," Geode went on. "She won't look at another child without crossing her eyes. Of course the others make fun of her. And then—" Geode shook his head.

"She hit Pomu's leg this time," said Haemum. "He needed three stitches. I'm sorry—I'll watch her better."

"You can't be with her every minute. You need to rest, Sister. You must; do you understand?"

"I'm all right, Brother Rod. I just get these headaches—ever since we hauled the last tumbleround. You know how they smell. The medical service couldn't find anything, so I'm sure it will get better."

Rod was silent. Vague fears stirred in him, of what he could not say. "I'll talk to 'jum." What were they to do with he?—he wondered. An older child . . . she needed time to heal; but she was a danger to others, and no one could watch her every second. If only Reverend Mother were here.

'jum sat alone on her bed in her filtered room, more sullen than ever. "'jum, why?" Rod asked. "You know the rules. Your brothers and sisters don't want to hurt you. We need to keep each other safe."

"They're stupid." Her voice was low and grudging as if forced out of her. "I don't like them." On her arms, Rod saw, a rash was spreading, which must feel unbearable. It was a relatively mild reaction to something on Prokaryon, but if Haemum's treatment failed it might become serious.

Suddenly Rod wished he had left her to die on Scarecrow Hill. She was half dead then; a day or two more would have ended her misery, and never brought the colony the burden of this traumatized child. The depth of his own feeling surprised and shocked him. Whatever good he might do was all useless in the end, if he could feel such hardness toward one suffering human being.

But the girl was alive, here; and somehow she had to be dealt with, along with the tumbleround and the defunct lightcraft. A voice from long ago welled up within Rod, the voice of his old Academy master. He held 'jum by the wrists and made her face him. "Listen. You are one of us, and *you will live by our rules.* Do you understand?"

The girl did not reply. "The sun's rays are not infinite," she said at last in a defiant tone. "I will count their photons."

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Outwardly Rod carried on as always, but inside he felt forsaken. He needed the Spirit more than ever, but when he called, his soul heard only emptiness. He was losing weight on Prokaryon food, and by day he could think of little else. At night he dreamed of Khral, again and again. It always felt the same: a sense of longing and satisfaction, a feeling of the deepest joy to become one with her. In the morning he would awaken, bewildered and remorseful. He prayed for release, but instead found himself looking forward to the nighttime, while dreading the shame of awakening.

Rod knew he had to talk with someone. He approached Geode, after evening prayers. Overhead the molten moon awaited the nightly clouds. *They'll boil off the continent,* Diorite had warned, just like Prokaryon's moon. It could not happen—*must* not happen, Rod told himself yet again. But he could do nothing, without healing himself first. "Brother, I have a problem."

Geode sighed. "Not the roof again? We really can't afford another roof job."

Rod smiled despite himself. "I'll keep the roof tight, never fear. The problem is, I am distracted in my prayers. My soul strays, and I can't call as I should."

The sentient's eyestalks twisted and untwisted. "Distracted? Straying? Not you, Brother Rod. You're always the one to keep me straight."

Taken aback, Rod murmured, "Well, thanks, Brother."

"It's true. You always remind me to respect the poorest and least fortunate of our fellow creatures; even poor servos too dim to grow sentient."

"I try my best. But now I feel . . . empty, somehow, and I long for things that are wrong."

"That's how I feel," said Geode suddenly. "Especially about Station; I can't help imagining all sorts of ugly fates she deserves, for buying Proteus's servos. Like the old Urulite overlords, most of whom had simian blood, but it never kept them from owning simian slaves." He raised two limbs fluttering. "So much evil fills the world, it's hard work to untangle one's self. That's why I pray all the time, without ceasing. But you are human—you can scarcely manage one task at a time, let alone several. You need time to retreat from the world."

Rod considered this. "A retreat might help. But how could I make the time?"

"You could spend one afternoon, at least, in the wilderness, meeting the Spirit. No, really; I can manage for an afternoon."

The next day, leaving the children settled for the moment, Rod strode out alone across the brokenhearts. Despite the heat he wore his formal robe, to help focus his search. He silently repeated all the litanies, and tried to open his mind—for what, he was not sure. That was the way to start, he knew: with unsureness. Only when the mind cracked open its own worldly certainties could a glimpse of light appear.

He walked steadily beyond the tilled fields, over the windswept

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reaches tended only by whatever Spirit filled Prokaryon. The wind brought many scents, of four-eyes and crushed loopleaves, of the river that flowed in among the singing-trees. He let his mind run free, free as the child he was before he entered the Academy, the child who used to play with old fossil bones out on Trollbone Point; the bones of the creatures boiled off before humans came.

He found his mind calling out around him: What are you, you rolling creatures and tangled leaves? What is your place in the cosmos? Every form of life that ever was had its day and died, even old *Architeuthis.* If someday his children played with singing-tree skeletons, what did it matter? Was Prokaryon any different? Why was it so crucial that Mother Artemis convinced the secretary?

He listened for reply. But no reply came to his mind; only to his heart, to the part of him that was beyond reason. For a moment he caught a glimpse of understanding, of why some humans could decide by logic to boil off a world. Of course, no logic protected a living thing, only sheer desire; a desire fed by the Spirit. He needed the living beings of Prokaryon, absolutely, for all that he could barely eat their food.

The wind rose again, sighing its assurance. It brought a scent, the very faintest trace, slight but unmistakable, of glue. Rod stopped. He meant to veer off, to avoid any distracting encounter. Instead, his feet took him forward again.

The odor increased. Sure enough, the shapeless mass of a tumbleround appeared. A whirr or two alighted on Rod's arm, never staying for long. His curiosity rose insistently. What could this thing be, that sent out its little carriers of microzoöids to the winds? To reach other tumblerounds, of course. But what would they say, if ever those messengers could talk to him?

All those times this enigmatic creature had crept over to peer in at his window; now, for the first time, here he had come to visit it.

Rod's head ached and his eyes swam. The sun was hot, and the gluish odor overpowering. He tried to turn and leave; but he was transfixed to the spot. His eyesight went blank, turning different colors: first blank red, then green, then blue. Then mixed hues appeared in rapid succession, until he lost track of them and let out a wordless scream.

The hues subsided and lost definition. Now shapes of darkness appeared, as if some unseen hand were trying to paint on his retina. The shapes were tantalizing, yet their sense eluded him. After what seemed forever, a dark blur seemed to coalesce and take rudimentary form. The form parted into several projecting lines; he counted five. A prime number? Then, in an instant, he knew the shape for what it must be: an outstretched hand.

For just a moment, the wind and field reappeared before his eyes. It was just long enough for Rod to reclaim his senses and turn to flee across the fields. He did not stop until he reached the compound, where he leaned on the gate, gasping for breath, his clothes drenched with

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sweat. *An outstretched hand . . .* There was one meaning for such a sign, in any human culture he knew.

Chapter 11

The Secretariat, the highest authority of the Free Fold, occupied a giant orb of nanoplast that rolled lazily through space above Elysium, pulsing with a million urgent signals to and from every human corner of the galaxy. The daily cycle for its myriad officers, ambassadors, and petitioners had just reached morning.

Within the brain of Secretary Verid Anaeashon, nanoservos with their gentle electromagnetic fingers were rousing her mind, just as it completed the deep phase of sleep. At just the best moment for optimal mental function, the nanoservos swimming in her cerebrospinal fluid nudged her awake.

Verid's eyelids opened. Beside her in bed, beloved Iras was stretching already, and Verid's skin vibrated with memory of the evening before.

Their chamber had no windows, of course, buried as it was within many levels of shifting nanoplast. But morning sunlight poured in nonetheless, as real as one could imagine. The front of the room filled with butterflies, multicolored heliconians, flitting and hovering above lush green foliage. For centuries Verid had begun her day watching these brilliant evanescent creatures in their garden, contemplating her own fate.

But she had a long day ahead. The butterflies soon receded, and her day's agenda hovered above her eyes, the first of ten thousand-odd items prioritized by her nanoservos.

Iras's arms sneaked behind her back and cupped her breasts.

"You distract me, dear." Nonetheless Verid did not pull away. The cerebral nanoservos captured "yes" and "no" from her thoughts as her eyes scanned the list. Activists for simian rights on Urulan—yes, meet them first, although she could offer little more than publicity. The same for the sentient rights activists. Valan and Bronze Skyan trade talks on "stable" nanotechnology—yes, but later on, to avoid awkward juxtaposition. Prokaryon: update on privatization, and on that mysterious disease outbreak. Illegals from L'li—that crisis would take the rest of her morning.

By now Iras had withdrawn to attend to her own list from Bank Helicon, reviewing her portfolio and seeking new prospects to cultivate. Meanwhile the bedclothes had shrunk themselves away, and a cleansing chamber had molded itself out of the wall. Verid rose lightly, her Elysian muscles in perfect shape as they had been since her birth in the *shon,* the genetic nursery where all Elysians were reared. The cleansing chamber breathed a mist that settled in droplets all over her, full of molecular sorters that dissolved waste substances while leaving healthy epidermal oils behind. By the time her skin was dry, the bed had been transformed to a semi-circular lounge, with a table thrust up from the floor, holding a tray of flower cakes.

A fresh talar floated onto her shoulders and molded itself down her body. From the lounge, Iras looked up at her, her blond hair floating luxuri-

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antly above the butterflies cascading down her talar. "Isn't your list done?" She could tell from Verid's expression that the list still hovered in her mind.

"Almost." Verid knew how Iras valued this time, the one meal of the week they spent alone together, for all other breakfasts were meetings, and state dinners hopeless. But Verid never failed to scan her last nine thousand listings, mostly would-be petitioners for one cause or another, despite her assistant's efficient shunting of them to appropriate departments. Yes, yes, yes . . .

Artemis. The Reverend Mother Artemis, a creditless cleric from an orphan colony on that debt-ridden colonial world, priority number nine thousand three hundred and fifty-two.

From within her head, the nanoservos generated a voice. "Where do you place item 9,352, Secretary?

"Today," she told them, "just after the sentient rights group."

"Very well. May we be instructed for future reference?"

"You couldn't have known." Mother Artemis had no official standing to see the secretary, and whatever she needed, Verid could do even less for her than for the others. But her centuries-old memories of Artemis would never fade.

At last she sat beside Iras, whose hand reached to hers. "Are the trade talks that bad?"

"Not too bad." The talks were completely stalled.

"You look down about something." Iras tasted a cake. Her blond hair fairly glowed in the morning light. "You ought to be more happy. You're only the most powerful person in the Fold."

"And loved by the most beautiful woman." Verid smiled. "Don't write me off yet; my Final Home can wait." An unusual number of prominent aging Elysians had chosen their Final Home this year; the news was full of it.

Iras looked thoughtful. "My old shonsib Kerelis went, though, after nearly seven centuries. I'd seen the warning signs, the last decade; he kept having more and more of his old memories erased. . . ."

Verid shuddered. It was a dangerous habit for Elysians to have painful memories removed. Not that she had never felt tempted to give up the centuries-old longing for lost friends. But the more one erased, the less one's own life remained. To end one's self had once been the worst crime in Elysium; today, it was far too easy. "Iras," she said suddenly, "you must be looking forward to your trip to Prokaryon."

"Definitely." Iras was heading out with Nibur to attend the "Opening" of cleansing the Prokaryan continent. It was mainly for show, of course, just a spout of steam from the sky; the real work would exclude spectators. "What a fascinating world—all those little creatures rolling along."

"That's why you're wiping them out."

"Just the one continent." She gave Verid a close look. "You did say the Proteus loan was OK. You could have said no."

"Someone had to do it." After two centuries of development, Prokaryon was a financial disaster. All the research that went into that ecosystem,

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and the lifeshaping of the colonists, and still only children and sentients could live there. The planet drained precious resources from the Fold, resources needed to fight the plague on L'li and support the shaky economies of Urulan and other worlds. Another century more, and things might look different. Even another decade— Station assured Verid that full human colonization was just around the corner. But how far was that corner? The patience of the Fold had worn thin.

Something had to be done, before they voted to simply give up and terraform the whole planet, zoöids and all. If Nibur cleansed one continent, it would at least buy time for the rest. Unless it only hastened the rest. She sighed. "Take care of yourself, dear. There's an outbreak of some sort, at Station."

Iras laughed. "So that's what you're worried about. Never fear; we don't get sick." Elysians, with their augmented immune systems, took the view that microbial illness was for mortals.

Verid watched Iras speculatively. *Connect, connect,* she thought instinctively. "You know, dear, I've found something to interest you. Another descendant of Raincloud's."

"Really? I've accounted for all but three." A word to the room, and Raincloud herself strode forth full size on the holostage, her dark face bold beneath her orange coils of hair, her arms raised in a martial arts stance. Raincloud had been a mortal friend of Iras's, some two centuries before. An emigrant from Bronze Sky, Raincloud had settled among the Sharers. Iras kept track of all her descendants, visiting and recording them, and bestowing favors. "Where is her descendant?"

"On Prokaryon. A Sharer lifeshaper with a research lab on Mount Anaeon."

"A Sharer lifeshaper? On the Spirilla continent?" Iras frowned. "You're up to something."

Verid returned her look innocently. In fact, she had sought long and hard to make Iras "connect" with Prokaryon.

"We have to do something," Iras reminded her. "Else those L'liite ships will just keep coming."

In her receiving room, complete with real oak desk and bookshelves, Verid whispered her last notes on the sentient rights activists. They had shown shocking evidence of sentient machines held in virtual slavery, prevented from claiming their freedom, forbidden even to think the word *I*. Of course, everyone knew these factories existed, and even they would look insignificant compared to Nibur's Proteus, which eliminated sentience altogether. But at least her brief hearing would keep the facts in the public eye.

"The Reverend Mother Artemis of the Sacred Order of the Spirit," prompted the nanoservos in her brain.

Mother Artemis glided into the room, trailed by three snake eggs at about eye level. They had to have their thirty seconds.

"Artemis," Verid exclaimed, grasping her hands, and the sentient's snakes of hair stretched toward her. "It's been decades, hasn't it?"

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"Too many." The face wore its brightest smile, and her starsign shone on her neck. "But you did well for the nanas; you kept your promise." The "nanas" were the caregivers for all Elysian children. Their freedom had required hard negotiations.

"So did you," Verid reminded her. "Without you, who knows? We might still be at the table! But you left the nursery—to found your own at a far star. Now, what brings you from your children?"

"I miss my babies," Mother Artemis admitted. "But now, I fear for their lives."

"The transfer of your colony—has it gone wrong?"

"It must not happen! Our children have devoted our lives to cultivate this plot of land, and now they are to be rooted out?"

"It's only been a few years," Verid pointed out reasonably.

"For children, that is their entire lifetime. And for our non-human hosts, who knows?"

Verid's eyebrows shot up, and the snake eggs came forward. "Non-human intelligence has yet to show itself." The standard line she had repeated for decades.

"Those tumblerounds looking in at our windows, they're intelligent. Everyone knows it, even if our scientists can't prove it." Mother Artemis raised her hands. "How can you immolate an entire continent of our hosts?"

Verid waved away the snake eggs; enough was enough. Then she sank herself into a chair.

Artemis did not sit down, but shaped her nanoplast downward to meet Verid's level. "It's been a long time, Verid."

"Too long," Verid agreed. "The sentient rights movement still needs you."

"What more can I do?" Mother Artemis' voice was low. "Today, even Station herself buys lost souls from Proteus. It's a disgrace."

Verid nodded understandingly. She had watched the wealthier sentients gradually ape their former masters. No wonder the Reverend Mother had gone back to raising babies.

"And you?" Mother Artemis demanded. "You yourself founded Prokaryon. How can you give up this precious world now?"

"I'm trying to save it," Verid sighed. "Put to a vote, the Fold would terraform the whole planet tomorrow. One continent—that's a compromise." Compromise, the story of her life.

"But why make it easier?"

"It's a dangerous game," Verid admitted. "But it does buy time. The Fold representatives can tell their home worlds they made a place for the L'liites, yet they still saved the planet."

"The Sharers will protest."

"Another fallen ship from L'li will silence them." The Sharers themselves were an endangered minority, though their ideas had spread through the Fold.

The starstone at the neck of Mother Artemis seemed to sharpen. "Citizen Anaeashon," she exclaimed. "Where are our rights—the rights of the settlers, citizens of the Fold? Where is our contract?"

"You have your rights, but you de-

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pend on us for your upkeep, especially your newest settlers."

"Our settlers have all been life-shaped. Even without new colonists, we can manage on our own. Set us free."

Verid raised an eyebrow. "No new colonists? That's just the problem: Where will all the L'liites emigrate?"

"There won't be any more emigrants, in a few decades. The creeping will see to that."

Astonished, Verid looked at her hard. "You are right. In another generation, L'li's billions will actually decline, and the survivors will experience labor shortage. The desperate ships will end. But a few decades—a long time, for mortals. Besides," she added quietly, "no official wants to admit that we're actually going to stand back and let the plague do its work."

"I am but an atom in the breath of the Spirit. I have never claimed to do more than dry the tears of a few children. If another ten billion die beyond my reach, at least I have shared what I can."

"And I'm trying to save what I can of your world," said Verid. "One continent buys time for the rest. Is that so wrong? Every planet survives its disasters."

"You're wrong. You miscalculate."

"Really?"

The sentient moved closer. "Surely you know Prokaryon's mineral wealth. Titanium, aluminum, let alone the gold. Metals long-gone from every other planet's crust. And the gemstones—you know what mortals will do. You've seen it on Valedon."

For some minutes Verid thought in silence. Elysians cared little for solid objects; they prized the protean delights of the virtual. But mortals were different. "There could be a gold rush," she admitted. "I can't rule the future."

"You can help us fight."

Verid met her gaze. Then her chin tilted a fraction. "If I put a hold on your colony, the others will call it favoritism."

Mother Artemis spread her hands. "Verid, I ask you: *Hold us all.* All of the colonies on Prokaryon. They all are suffering as we are."

"Most of them have already bought the promise of better land." Verid rose from her seat, her talar swishing around her legs as she strode to the holostage. From the light emerged a landscape, the land of Prokaryon. Land of any sort was a mystery to Verid, who dwelt from birth in a city floating on a shoreless sea. But Prokaryon, with its unending rows of ring-shaped trees and its leathery rolling inhabitants, was a mystery beyond imagining. "So this is your land," she mused, adding a Sharer proverb, "'Land claims the dead.'"

"The land of Prokaryon is our death and rebirth."

The Secretary sighed. "I'll put a hold on your transfer." Iras would be incensed, she realized. "But be warned, Nibur will force you out, one way or another."

"We know. Thank you, Verid, from the depth of my soul."

On the holostage, something had emerged out of the Prokaryan forest. One of the annular trees was not quite a tree. It had no firm roots, Verid saw, only temporary roots extending for-

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ward and back, to gradually pull and push itself. A mess of tendrils bearded it all over, clouded by insects. "Is that it, Artemis?" That verminous creature, the master of Prokaryon?

Mother Artemis sketched a starsign. "The Spirit alone will tell."

Verid watched the creature keenly, committing every detail to memory. "When the master awakes and needs reckoning—send for me then."

The *Proteus* was coming out of its last fold hole. Nibur had a private acceleration compartment for himself and Banga. The retriever panted quietly, accustomed to the nanoplastic restraints that shielded it and its master from the centripetal force as the ship spun down the hole through the space fold. At last the restraints dissolved, indicating they had cleared the hole. Nibur rubbed Banga behind the ears, and the eager tail brushed his arm.

Now he was impatient to hear from his staff about progress on Prokaryon. His staff called in, not as walrus today, but as angelfish, his latest variation on the ocean of *Proteus*. "Is the Opening on schedule?" On a remote uninhabited island off the western coast of Spirilla, the first steam would pour in. Of course, they had tested the white-hole connection already, in secret, two months before. Several delegates had wanted to see that, before the vote.

"The white-hole link is set, and the water pump is up." Energy from the white hole would vaporize water pumped from the ocean, which would swiftly cleanse some hundred square kilometers.

"Excellent," he told the fish. "And how are the locals—all moving on?"

"The Three Forks bauxite miners are winding up operations on schedule." The fish blew wide bubbles, its long parti-colored fins trailing. "Colonial Corundum is stalling however. They claim the wrecked L'liites are still alive; they say they found tracks."

"Tracks indeed. What do they take us for? Tell them to cut it out, or we'll send the Fold more evidence of their misdemeanors."

The fish bubbled, "The Mount Anaeon research lab still fails to respond."

"Tell them we'll send in the octopods." The Fold required preservation of all ecological research, but his patience had grown thin. Nibur watched the ever-shifting swirls of foam wend across the sand at his feet. He was tired of ocean, he realized. It was time to fashion something new of *Proteus*, something to stimulate the senses afresh. What should it be? The fiery landscape of Bronze Sky? Or the green hills of Valedon, with their cliffs full of ancient bones?

"One last colony remains, on a last-minute hold order from the Secretariat."

"What?"

"The so-called Spirit Colony."

Nibur was puzzled. What could Verid be up to, with this last snag? If she intended to hold him up, her attempt was vain indeed. He would ask Iras what she knew of it.

Iras soon emerged from her own compartment. Her train was dissolved into a bundle behind her, the easier to disembark. As Nibur joined her, half a dozen octopod servos emerged to defend them from any attack or contagion. Elysians always brought protec-

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tion, outside their idyllic home world.

"I trust my ship served you well, shonsib," Nibur said.

"The smoothest trip I ever made." Iras's hair flowed down the butterflies of her talar, every strand in place. "I should travel more often."

Nibur smiled. Iras was known for her reluctance to leave the comforts of Elysium.

"All set for the Opening?" Iras asked.

"A new beginning for Pavonis Three."

"You certainly wasted no time."

"It's best this way," Nibur said. "Like taking down a historic building—once the first corner goes, no more protest." The docking was taking longer than it should, because of new quarantine regulations. Mortals and their sickness—they should manage their bodies better. "While we're waiting, perhaps you can explain to me this little problem with the so-called Spirit Colony?"

Iras frowned. "Verid's last gesture. What's a month extra?"

He nodded politely.

"There is another matter, in fact, which may prove more, shall we say, significant?" Iras smiled. "The diversity score you reported for Spirilla's ecosystem: one-point-five on the scale of one to ten, am I right?"

"The equivalent of commercial farmland, yes."

"That was the *average* score, shonsib. But you never mentioned those small regions whose species diversity scores eight or nine. The eastern mountains, for instance."

Nibur shrugged. "Prokaryon's masters must have their own nature preserves."

Iras looked at him with interest. "Do you believe in the hidden masters?"

"I enjoy a good fantasy as well as anyone. Actually, my staff is well aware of the mountain diversity. We are sampling all species for transplantation."

"Nonetheless, shonsib, I'd like to take a look at this . . . nature preserve. Mount Anaeon, to be precise; there's a Sharer research lab."

"As you wish." Inwardly Nibur swore to himself, much annoyed. He had promised Iras to show her anywhere, betting that her soft city habits would keep her to well charted ground. "If we lose an octopod down a cliff, we can always produce more."

"Precisely. Now, if you'll excuse me, I must freshen up before we face the snake eggs." Iras left, her talar unfolding behind her.

Nibur shrugged. After all, he did need to check the relocation of that laboratory. And while there, he could be seen supervising species collection.

Then it dawned on him. Of course—Mount Anaeon would be the next incarnation of *Proteus*. Sheer mountains, full of elegant arching trees and quaint rolling creatures to embody his messengers. An esthetic challenge beyond compare.

"News just come in," called an angelfish. "Solaris Sunracer sold its last lanthanide site to Aldaran." Aldaran was owned by a Valan firm, controlled by an Urulite holding company owned in secret by Proteus. "We've reached fifty-one."

Fifty-one percent. Euphoria filled him like a drug. A continent was nothing; Nibur now owned a controlling

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interest of all holdings on Prokaryon. In effect, he owned the world. And he could show all the Fold that when the last Prokaryan landscapes dissolved, they would not vanish—they would be immortalized.

Chapter 12

Rod's head ached for another day and a half, but he had no time to think of it. In the morning the floor of the kitchen was soaked from a leak in the roof. So he climbed up to check the roof, then spent an hour assembling dried fungoids to use for repair. Chae helped him chop them into small pieces, then add water with a special powder that made them like paste. He then climbed carefully up the ladder to apply the paste to the cracks. In the sunshine, the paste would harden into a surface as impervious as concrete.

Overhead, far above the roof, a vast flock of scarlet helicoids came migrating westward. Rod paused, overcome by the sight of tens of thousands of the whirling creatures that filled the sky to the far horizon. All the beauty of this land could be wiped out, at the whim of humans light-years away. Mother Artemis must have met with the secretary by now. He hoped for a neutrinogram, but the holostage was still occupied by the L'liite protesters.

"Brother," hailed Geode from below. "Come quick to the holostage. It's Sarai."

"Sarai? How did she get through?" The L'liites must have left, thank the Spirit. But whatever could Sarai want of him, Rod wondered as he descended the ladder with care. "Keep the paste wet, Chae," he told the boy waiting dutifully below.

Geode kept a discreet distance from the holostage, for Sarai unnerved him. In the column of light the unclothed Sharer could be seen pacing back and forth, her breasts swaying. She seemed even more agitated than usual. "How dare you tie up your holostage and refuse me."

"It was hardly our choice," Rod told her. "We're glad our visitors finally had enough."

"I had to pull medical privilege." Sarai glared at him. "It's not fair," she exclaimed. "My competitor has all kinds of help in her work—and what have I got? Nothing."

It took Rod a moment to realize she must be referring to Khral. "It's true," he agreed carefully. "Khral works at Station, with many collaborators."

Sarai stopped and stared straight at him. "*You* help them, too. Your colony sends you to collect their samples. Why can't you send *me* an assistant for a change?"

For a moment he returned her stare. Then he looked down. "We are forever in your debt, Sarai," he told her, thinking of Gaea running, her precious legs healed. "I would help you if I could. But now we face . . . hardships. Brother Patella has yet to return, and for a time we have lost our Reverend Mother. I can't possibly be spared to help you, nor Khral either."

"It's not *you* I need. I need someone intelligent." She waved a hand impatiently, then gave a very fierce look. "That girl—the one you brought last time."

He stared again. "You mean *'jum?*"

"That's right."

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"Impossible," said Rod curtly. "'jum is a child. She needs proper rearing."

Sarai threw up her arms, and the webbing flashed between her fingers. "I knew it! I knew the one time I asked you Spirit Callers for something, you'd say no. After all I've done for you." With that, the holostage went dark.

Shaking his head, he turned to Geode. "Can you imagine?"

The sentient folded up his limbs. "Well, I don't know."

Rod frowned. "What do you mean?"

"I mean, well—we might consider it, that's all. After all, we're shorthanded, you and I. We could send her there until Reverend Mother returns."

"Send a child to that mad Sharer?" Rod was nearly speechless. "How could you? You never liked 'jum in the first place; you wanted to leave her on that hill—" He stopped, shaking. "I'm sorry," he said wearily.

"No, you're right. I don't take to older children: I'm not so good with them. I know the babies; I can hold them, and feed them milk. Whereas I just don't know how to . . . feed 'jum."

"Nor do I." Rod admitted. 'jum now spent all day alone in her room, making figures with sticks and pebbles. The other children kept their distance. At times, Haemum seemed to reach her, but Haemum had no more time.

Geode said, "Why not ask 'jum herself? She listens to you."

Rod gave a grim smile. "We'll see."

He found 'jum sitting on the floor, amid an array of little sticks arranged in intricate triangles and squares. She seemed absorbed by some internal calculation, and he had to call her name twice before she looked up. "I have something for you to think about, 'jum." He tried to hold her gaze. "Do you remember Sarai, the . . . lifeshaper, the one who cured Gaea?"

'jum nodded.

"Would you like to go and stay with her?"

At this, 'jum nodded again, her chin raising and lowering as if her whole body nodded too. Surprised, Rod felt slightly hurt. "I can't stay there with you," he warned.

"I know."

He tilted his head. "Why, 'jum?" he asked curiously. "What do you like about Sarai?"

"Sarai lives on a high place. Like I did."

There was no question of taking 'jum on a three day's journey to the mountains, leaving Geode to manage alone. Diorite's newly sentient lightcraft would have helped out, but instead Rod found himself calling the research lab.

The image of Khral coalesced on the holostage. Rod suppressed his sharp delight at seeing her, afraid she might see into him. But she greeted him the same as ever. "Oh yes! Rod, are you ready to help out in the field again? We made some fascinating observations of tumblerounds, but the work could go faster."

Recalling his encounter, he shuddered. "I wish I could, but we're shorthanded until the Reverend Mother gets back." It was all right, he told himself; the dreams meant nothing, now that he saw her again. He want-

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ed to tell her of his encounter with the tumbleround; but now it would only sound foolish, a tired man's vision in the sun. "The microzoöids that grow in the tumbleround—they can't grow in humans, can they?"

"No, still no evidence of that."

"You will let me know if you . . . find out anything? I mean, if the tumblerounds are dangerous in any way, we ought to know."

Khral smiled. "Of course, I'd let you know. But really, you've had them around for years, haven't you?"

"That's right." Yet this year they seemed . . . different. As if somehow they had awakened.

"Come up and hear the latest, when you can. Quark will be glad to pick you up."

"Actually, if Quark isn't too busy, he might take us again to Mount Anaeon."

"To Sarai? Thank goodness," she exclaimed. "Sarai hasn't spoken to me since I told her we'd gotten the microzoöids to grow. I tried to flatter her as best I could, but she absolutely went berserk. She thinks I stole her data." Khral shook her head. "Now she'll have to see you. Maybe she'll relent and let Quark give her those strains that finally shipped in from Science Park."

So the child called 'jum was brought to the brow of Mount Anaeon and left there, within the tunnels of Sarai's laboratory. As Sarai watched the child, she found herself thinking and feeling things she had not felt for many a year. To be sure, the L'liite child was pitifully foreign, not a web between her fingers and small for her age. But her eyes were bright and keen; they did not miss a nook in the cavern, between the leaves of secretory plants with reagents dripping slowly, nor amidst the touch pads and speaker points of the Valan-built holostage. Sarai's own daughters had once looked the same.

Her daughters, and her beloved Aisha; for a moment the memory was too terrible to live through. Sarai felt herself slip away, into whitetrance. Her fingers turned white first, then her limbs, as the breathmicrobes in her skin bleached white, and her blood concentrated within her critical organs, leaving just enough circulation to keep her alive. Aisha, and their daughters. Long after the day the storm-maddened seas had swallowed them, they dwelt there still, somewhere below the ocean deep. Sarai had fled that ocean; she had flung herself as many light-years distant as she could, even burrowed into stone. Yet the ocean remained, inside.

Now, outside herself, she could not ignore this foreign child, who had shared her will to come. The child was alive in this world and would share her care. So Sarai returned slowly to the world of the living. Slowly she stirred, flexing her fingers and stretching the webs, still pale. It occurred to her that this child might never have shared sight of whitetrance before, living among those ignorant clerics. But the child sat watching, her eyes wide but calm. Sarai regarded her approvingly.

"Ushum," she whispered, softening the child's name into something the ocean might have spoken. The poor

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thing was covered with eczema; whatever were those clerics thinking? Sarai clucked at a clickfly, who called over several of its sisters to alight upon the child and deposit secretions on her skin. "Sit still, Ushum, until the clickflies are done; they will clear your rash." Her eyes narrowed. "It's about time you came," she added curtly, afraid of too much tenderness. "I need help with my work; there's so much data to collect. And something tells me you'd be good at counting photons."

The child nodded. "All the photons in the world."

Sarai felt her pulse quicken. After so many years struggling on her own, it was a heady experience to find someone who might share the excitement of her work without stealing it. That Khral for instance, with her tricky sentient friends. What a fool Sarai had been to send her precious microzoöids. After all the trouble she had gone to, all the mixtures she had tried. Sarai had stumbled by chance onto just the right proportions of zoöid and phycoid that her little sisterlings needed to grow. She was sure those stupid scientists would never get it, and would have come to beg her for the recipe. Instead, with all their fancy machines, they tried tumbleround flesh—and it worked. And that Khral had the gall to call her and brag about it.

That Rod was a trickster, too. He still looked and sounded like a Valan death-hastener, for all that he joined the clerics to raise their orphans. She would not trust him until he bore his own child.

But what terrified her most was the children. All her lifeshaper's instinct and training made her unable to refuse care of a sick child. If the clerics ever found that out, she would spend the rest of her days tending one child or another.

"Well, Ushum, let's get to work. You're not hungry or sleepy now, are you?" Children were subject to such things, she recalled. But 'jum shook her head and rose expectantly, her small travel bag lying forgotten among the vines along the cavern wall.

Sarai called to her holostage, a machine of no intelligence, only rudimentary interactive powers. The usual column of light obligingly appeared, displaying several ring-shaped objects brightly colored. "I've grown these microzoöids in culture for several months now." Not from singing-trees—nor from tumblerounds either. From where, Sarai could not yet bring herself to say; she only shuddered at the thought. "In this recording, each cell is magnified a million-fold. They all glow different colors, don't they?"

'jum peered at the magnified microzoöids, her neck outstretched like a hummingbird sipping nectar. One plump little ring was pink, and a pale blue one even rounder, and another one turquoise. "Those two look the same," 'jum said, pointing to the turquoise, and to a ring that lay farther off across the holostage.

"Exactly! Those two cells are the same color. And now, as time passes, what happens?"

Gradually the colors changed, some greener, others bluer, until at last all the ring-shaped cells were turquoise.

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"Now let's replay that sequence, more slowly." At Sarai's command, the holostage reset the microzoöids to their original colors, with playback rate decreased a thousand fold. On this time scale, the little rings no longer glowed steadily; they pulsed. "You see?" exclaimed Sarai. "They emit little bursts of photons—in prime numbers."

"Five . . . seven . . . twenty-three," 'jum counted.

"Those are the easy ones," Sarai warned. "I've counted up to twelve hundred forty-nine. The numbers must mean words or letters of some sort. My theory is that *the rings share the same color to talk to each other. Like the little nanoservos we send* into your bloodstream to fix your genes: They have to share signals to coordinate their work, right?"

'jum thought this over. "What is their work?"

Sarai shuddered. "Not like nanoservos—not at all." How Khral and Rod and all the rest of them would faint if they knew. "We'll find out what they're up to, perhaps too late," she said grimly. "I'll tell you, Ushum, where I found these microzoöids; but you mustn't tell anyone. They were—"

"Priority call," interrupted the holostage. "Please stand by for priority call."

Startled, Sarai glared at the holostage. "How dare you interrupt my work? I take calls when I please. The next time you—"

"Priority call," the stage repeated. "You refused our calls for two weeks, so a warrant was obtained."

A deep roaring sound of water filled the air. Above the holostage a wave of ocean rolled, a giant ravening curl of water such as was never seen on shoreless Shora. The curl grew small, reduced to a mere symbol hovering before a massive desk. Behind the desk sat an Elysian creature, whether female or male-freak, none could tell. It faced Sarai, apparently undeterred by her look of cold fury.

"Greetings," said the creature. "As you recall, I represent Proteus Unlimited, to whom the Fold has entrusted management of your research facility. Your work is most important to the Fold, and Proteus will transfer your project to an advanced, state-of-the-art facility under construction on the south-east quadrant of Chiron."

"Flying fish turds," Sarai exclaimed in Sharer. "You will do no such thing. Get off my holostage. For that matter, get off my planet."

The creature was unperturbed. "We will provide you with all necessary assistance to preserve valuable equipment. Our chief executive, Citizen Nibur Letheshon, will personally supervise the operation, along with our species preservation program. Please prepare for our arrival this week."

"I said, you will do no such thing." Sarai reached for the main power switch. "And you can tell your male-freakish master that if he ever sets foot on this world, *he will never leave alive."* ■

To Be Continued

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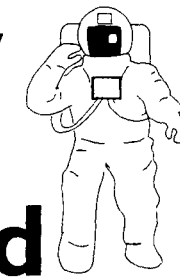
Part Two

H. G. Stratmann
& G. David Nordley



Biological Hazards and Medical Care in Space

The human body can adapt to a wide range of terrestrial environments. People in the high Andes and Himalayas adjust to atmospheric and oxygen partial pressures half those at sea level. With proper protection, humans can live indefinitely in the hottest deserts and coldest polar wastes.

But the environments of interplanetary space and the Solar System's other worlds are far more dangerous than any on Earth. People venturing off our native planet need a level of protection which strains the limits of current technology. While genetic engineering may someday successfully adapt the human body to space, as suggested by Olaf Stapleton in 1948, for now we must accept our bodies as a given and rely on medicine and engineering to help us live out there.

Part 1 of this article concentrated on immediate biological hazards faced by astronauts. In Part 2, we'll focus on long-term dangers of the space environment and speculate on how future advances may turn Earth people into *Homo astronauticus*.

Psychological Stress

Extended missions in space like those on Mir are associated with significant psychosocial stressors. Isolation, loss of social contacts, reduced sensory stimulation, anxiety, boredom, loss of privacy, dealing with emergencies, and overly busy work schedules can take their toll on the psychological well-being of astronauts.

Soviet studies of the behavior of cosmonauts show results similar to those in individuals confined for long periods

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to polar science stations or submarines. In the first several months of a mission, mood and work performance are generally good, with any irritability or anger directed toward "outsiders" like Earth-bound control personnel rather than crew-mates. In the next phase, fatigue, decreasing motivation, and emotional hypersensitivity and lability become prominent. Irritability and frank hostility are more likely to be directed at other crew members. If not adequately addressed (e.g. providing recreational materials like books or music, and occasional radio contact with family members) these problems worsen as missions grow longer and more isolated.

Circadian Rhythms and Sleep

The body's circadian rhythms are ones which recur over a period of about 24 hours. The sleep/activity cycle is the classic example, but body temperature, heart rate, blood pressure, and secretion of growth hormone, cortisol, melatonin, and other physiologically important substances also follow circadian rhythms. These rhythms result from endogenous "biological clocks" which, in turn, are entrained on cyclical environmental stimuli ("zeitgebers"). The light-dark cycle based on Earth's 24-hour rotation is the most important of these external factors.

The synchronization between a person's internal "clock" and external time cues like light/darkness can be disrupted by rapidly traveling through different time zones on the Earth's surface, producing jet lag or "desynchronosis." This produces insomnia, loss of appetite, fatigue, and stress-related illnesses like duodenal ulcers. It's not immediately disabling in most people and, given enough time, resynchronization does occur. Even without external light-dark cycles (e.g. someone in a dark cave without a clock), circadian rhythms persist, but with a "free-running" cycle of about 25 hours.

In space, 24-hour orbits with long-term stability can be established around all major planets except, perhaps, Mercury (due to solar perturbations). However, natural light-dark cycles approximating 24 hours are present only on Earth, Mars and its near-synchronous moon Deimos, Saturn's moon Mimas, and Neptune's moon Proteus. On the Moon, the cycle lasts 28 days. Of course, at Amundsen-Scott station on Antarctica, Terra, it's six months.

Depending on the spacecraft's altitude, an astronaut in low orbit experiences light-dark cycles due to planetary eclipses. In low Earth orbit (LEO), these cycles are between 80 to 140 minutes long, 30 to 40 percent of which is darkness.

Not surprisingly, sleep disturbances have been commonly reported during both orbital flights and the 1/6 *g* experienced by Apollo astronauts. These included insomnia and intermittent, poor-quality, or even prolonged (up to 12 hours) sleep—all of which can degrade work performance and alertness during routine or emergency situations. Other factors of the space environment, such as space motion sickness, lack of privacy, noise from life support system fans or

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active crew members, excitement, and unexpected events can also contribute to this problem.

Sleeping medications are used by about half of Shuttle crew members, and can be helpful. However, these medications can cause side effects, especially continued drowsiness after waking.

Problems with circadian rhythm shifts are addressed via a controlled preflight environment, with programmed sequences of light/dark and activities (meals, sleep, etc.) to assist adjustment to the time schedule required for mission-related tasks. In deep space, light-dark cycles are established by rotation of the spacecraft, or opening and closing shutters on windows and turning off lights in appropriate areas, as done on submarines and at Arctic/Antarctic bases. One of us remembers the sliding metal window shade in his room at a remote Alaska radar station that, thankfully, provided complete dark despite the 2 A.M. sunrise.

A 24-hour rotation spin period is possibly too slow to be stable for a small spacecraft with constant internal changes in its moment of inertia, but a higher spin rate with a 24-hour precession period could be arranged. A space station with two counter-rotating wheels would have neutral net gyroscopic stability, and thus would be free to rotate around another axis on a 24-hour period.

Prolonged Effects of Micro and Low Gravity

Chronic exposure to reduced gravity affects every major system in the human body. Neurovestibular (balance and orientation), cardiovascular (the heart and circulation), hematological (blood cell), and musculoskeletal (muscle and bone) systems in particular are sensitive to gravity. In time, these systems adapt and reach a new state of equilibrium in reduced gravity. Some of these new "set points," however, render astronauts more vulnerable to health problems, decrease work performance while still in space, and cause additional problems when they first return to Earth.

The effects of weightlessness vary greatly among individuals. This was dramatically demonstrated by Shannon Lucid, who walked away from her Shuttle landing with no apparent difficulty after six months in orbit, while the next American returnee from Mir thought it advisable to use a stretcher.

Similar but lesser effects are expected from exposure to low gravity as on Mars (38 percent of Earth) or the Moon (16 percent). However, the extent of the effects as a function of gravity is not known. Some educated guesses are that the overall effects will be negligible on Mars, but of concern on the Moon.

With the exception of the Apollo missions, human space flight has been confined to Earth orbit. Most data on the major adverse effects of long-term reduced gravity have thus been derived from exposure to microgravity on those missions, and will be summarized here.

Neurovestibular Effects

In addition to Space Adaptation Syndrome (see Part 1 of this article),

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sensory illusions occur in about 80 percent of astronauts in microgravity. When the astronaut moves within the spacecraft it seems as if the latter is moving toward them rather than vice versa. The inversion illusion—the sensation that one has turned upside down—can occur on transfer from one space vehicle to another. A combination of consistent visual and tactile references are important in this respect, as recognized since early USAF work on the subject.

After returning to Earth, some astronauts may feel extraordinarily heavy, and that they're being pushed to one side while merely standing. At night they feel "levitated" over their beds, and might even have to relearn how to put their feet back on the ground when rising in the morning without falling out of bed. They may walk with a wide-based gait and have a tendency to fall to one side, or keep walking straight when they try to turn a corner. These problems tend to be more severe the longer a person is exposed to microgravity, and may persist for weeks.

Prior to Yuri Gagarin's flight, serious concern was raised regarding whether the vitreous humor inside the eye would become opaque in zero gravity. This, like many such fears, proved to be nonsense—visual acuity doesn't seem to be appreciably affected while in space. Postflight, however, both visual fields and acuity may be diminished temporarily.

Cardiovascular Effects

Within minutes of exposure to microgravity, 1.5-2.0 L of fluid normally present in the lower body shifts to the upper part due to loss of gravity-induced hydrostatic pressure. This causes distention of neck veins, facial puffiness, reduction of calf diameter by up to 30 percent, and enlargement of visceral organs like the liver and pancreas due to venous engorgement. In some people, nasal congestion, nasal voice, and headaches occur. Also, the body erroneously perceives this fluid as "excess." During the first few days in space it's lost as urine, resulting in relative dehydration.

Orthostatic reflexes, which compensate for the normal drop in blood pressure on first standing in 1 *g*, become impaired. These reflexes are mediated by the sympathetic component of the autonomic nervous system, and normally include constriction of blood vessels and increased heart rate.

These effects are of relatively mild physiological significance while in microgravity. However, when an astronaut returns to Earth and stands for the first time, a liter or more of fluid shifts back from the upper to lower body. This, combined with reduced total blood volume and impaired orthostatic reflexes, can cause blood pressure to fall enough to decrease blood flow to the brain, producing lightheadedness or even unconsciousness. These abnormalities usually resolve within days with rehydration and increasing activity.

Heart size and mass decrease mildly during long (> 2 weeks) stays in microgravity, and recover quickly on return to Earth. Changes in heart rate, blood pressure, measurements of cardiac function, and occurrence of ab-

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normal heart rhythms vary widely among different individuals, but overall are usually not significant.

Hematologtcal Effects

The number and mass of erythrocytes (red blood cells) decrease slowly by 10-20 percent of preflight values during the first several weeks in microgravity, then start to slowly recover after about 60 days. This relative anemia may reflect both increased destruction and decreased production of erythrocytes. On return to Earth this abnormality takes several months to recover due to the relatively slow rate of erythropoiesis. In addition, an increased proportion of abnormally shaped erythrocytes (spherocytes and echinocytes) are seen. This finding doesn't seem to be functionally important, however, and disappears within three days postflight

Microgravity-induced changes in white blood cells and the immune system have been detailed in a previous *Analog* article (April 1989). Neutrophils, which combat bacterial infections, increase in number by an average of 32 percent. perhaps due to stress-induced release of epinephrine and glucocorticoids. Conversely, killer T-lymphocytes show diminished number and activity, potentially decreasing resistance to viral infections and recognition and destruction of cancer cells. Helper T-lymphocytes and B-lymphocytes (which produce antibodies) show little change in number. Eosinophils, which resist parasites, are decreased by about 62 percent.

* * *

Musculoskeletal Effects

Relaxed astronauts in microgravity assume a fetal position and lose the normal curve of the thoracolumbar (mid) spine. Height increases 3 to 6 cm, mainly from decompression of intervertebral disks. This may cause pressure on nerve roots and back pain. Height normalizes within a day of return to Earth.

Structural changes to skeletal muscle and bones represent one of the most serious hazards of long-term exposure to reduced gravity. In normal gravity, they're stimulated to maintain "normal" mass and strength largely by the constant stretching, deformation, and tension caused by activity. In microgravity, the weight-bearing muscles of the legs and back atrophy. Arm muscles are affected only mildly. Despite a vigorous exercise program, cosmonauts on Mir for over a year showed a 20 percent decrease in leg circumference associated with atrophy, and work capacity of the calf muscles decreased fourfold. Total muscle mass stabilized in 6 months around 80-85 percent of preflight value. Significant muscle weakness and soreness occur on return to Earth, and may take months to improve despite exercise.

Reduced gravity has even more serious effects on bones. The skeleton serves many critical functions. It provides support for the body, protects internal organs and the blood cell forming system in marrow, and serves as a reservoir for calcium. The latter is essential for muscle contraction, regulation of heart rhythm and function, blood clotting, and neural and hormon-

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al function. Exposure to microgravity causes demineralization of bone, decreased skeletal mass, and calcium loss. On the 84-day Skylab 4 mission, urinary excretion of calcium increased over the first month, then stabilized at a level high enough to increase risk of kidney stones. Fecal excretion continued to increase linearly without leveling off, indicating continuing loss of calcium from the skeleton.

The mechanism for bone loss isn't established. Activity of osteoclasts (cells which reabsorb bone) seems unchanged, while that of osteoblasts (cells which form bone matrix) is decreased. The net effect is brittle bones and risk of fractures, especially on return to Earth. With vigorous exercise programs, the degree of total bone mass loss is similar to muscles, averaging 15-20 percent in missions ≥ 6 months. Weight-bearing bones like the calcaneus (heel bone) may show a greater percentage of loss.

This is better than the 30 to 40 percent loss of musculoskeletal mass seen in chronically bedridden individuals on Earth who can't exercise. However, it's not known how effective vigorous exercise will be for much more than a year in microgravity, or the reduced gravity of the Moon or Mars. Also, the ultimate degree of musculoskeletal loss that will occur in individuals who don't exercise constantly in those environments (e.g. due to injury) isn't known. A reduction of bone density to < 60 percent of "normal" markedly increases risk of fractures. If bone loss doesn't plateau at more than this value with or without exercise countermeasures, it will set an upper limit for how long an unmodified human can safely stay in microgravity without an unacceptable risk of fractures after returning to Earth. After returning to Earth gravity, bone mass increases—but may not return to normal even years later.

Medical Approaches to Microgravity

Many microgravity-related problems can be treated with exercise, diet and appropriate medicines.

On Earth, isometric exercise (sustained contractions of muscles against resistance, as with weightlifting) can increase muscle mass and lead to a stronger, denser skeleton more resistant to the adverse musculoskeletal effects of microgravity. It's difficult to reproduce the training effect of isometric exercise in reduced gravity itself because "heavy" objects don't offer the same resistance to movement. However, various types of resistive devices, such as ergometers and spring-loaded or elastic equipment, can be used instead. Dynamic tension exercises (remember those old Charles Atlas ads?), which play one group of muscles against another in slow movements, might also prove useful where little equipment is available.

In isotonic (aerobic) exercise, muscles alternately contract and relax (e.g. running). Bicycle ergometers, treadmills, and rowing machines can be used. Elastic tethers and other types of restraints are required to secure the crew member to exercise devices. Ergometers can also be used to exercise arm muscles.

In short-duration flights aboard the

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Shuttle, exercise sessions are typically limited to daily sessions up to 35 minutes using a leg-powered treadmill. On long-duration missions on Mir, cosmonauts exercise for up to 3 hours a day in two sessions.

Isometric and isotonic exercise using these devices can substantially reduce muscle atrophy, improve coordination, and maintain overall work capacity. Bone loss is reduced by intensive isometric exercise, but aerobic endurance exercises (like brisk, prolonged walking on a treadmill) are considered ineffective for this purpose.

Cosmonauts also use an elasticized suit which provides passive stress on muscles of the back and legs. This "Penguin" suit is worn for about 8 hours a day. Electrostimulation of muscles to maintain tone and reduce disuse atrophy was also used in the past by the Soviet space program. However, the effectiveness of this method has not been established.

Three hours a day is a lot of time to exercise, and there may be medical ways to reduce this. Use of supplemental calcium, phosphates, and calcitonin (a chemical produced by the body which promotes bone growth) are being explored. Fluoride and clodronate have shown some effectiveness in studies using prolonged bed rest to model the effects of microgravity. Unfortunately, clodronate may also increase risk of cancer. Taking pills to significantly reduce demineralization and weakening of bone is currently a desirable but unrealized goal.

As described previously, orthostatic hypotension and loss of consciousness can occur on first standing in a higher *g* field like Earth's or, potentially, Mars. The simplest measures to reduce this problem are to ingest salt tablets and about one liter of water shortly before landing and not stand immediately after touchdown. The vigorous exercise programs previously described can also help.

Lower-body negative-pressure devices can assess the level of risk for orthostatic hypotension and, perhaps, partially alleviate it. Cosmonauts wearing a portable "Chibis" suit have sessions in which increasing levels of negative pressure are applied to temporarily cause fluid shifts back to the lower body. Antigravity suits (*g*-suits) act in the opposite way, increasing lower body pressure to prevent blood from pooling in the legs during and immediately after landing.

Artificial Gravity

As seen in the movie *2001: A Space Odyssey*, the engineering prescription for low gravity is fairly simple—a centrifuge. The Russian space pioneer, Tsiolkovsky, was probably the first to consider this problem seriously and propose the solution.

The *Discovery*'s drum appears to be about 6.5 m in radius, which would produce about one Earth gravity at 12 rpm. Most experts who've published on this subject would be uncomfortable with that high an rpm (including, perhaps, director Stanley Kubrick, since on the film it only rotates at 3 rpm—enough for 6 percent *g*, or about one Pluto gravity). People in rotating systems experience discomfort (e.g. dizziness) from radial motions that produce small sideways

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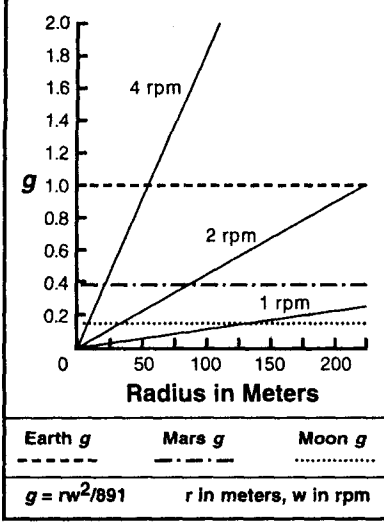
accelerations (Coriolis forces) affecting the inner ear. Authorities differ as to how rapid a rotation astronauts can stand. However, the rpm sensitivity tests assessing this have all been done on Earth, where the downward pull on the centrifuge cab confuses the issue of radial centrifugal gravity. Also, people are adaptable—what might give some initial discomfort may cease to do so fairly soon.

This is also a spacecraft design issue. As seen in Figure 1, the lower the rotation rate (w), the larger the radius of rotation (r) must be for a given level of artificial gravity (*g*). If the radius is too large, it might be impractical to enclose the centrifuge in a ship (as in 2001's *Discovery*) or even to rotate the entire ship. In this case, two spacecraft joined by tethers could rotate about each other.

Another problem with centrifugal gravity is that there are many engineering advantages to zero gravity, and rotating the spacecraft sacrifices these advantages, at least for the part of the mission that it is rotating. Rotation increases the complexity of the mission, as illustrated by the first major hardware effort of the British Interplanetary Society—they designed and built a despin platform for a periscope so astronauts could navigate from a spinning spacecraft.

Whether rotating spacecraft and space stations are actually needed is a matter of significant discussion among deep space mission designers. Conventional wisdom to date is that a combination of exercise, drugs, and recovery time on the surface of a planet will be sufficient for voyages in the inner Solar System and that provision of centrifugal gravity adds unnecessary risk and mass to missions. Advanced materials and new techniques for making tethers may change this assessment in time.

figure 1. centrifugal gravity



For large space colonies, rotation has been assumed by nearly everyone. The early pioneers envisioned rotating space stations and spacecraft, with separate zero gravity "construction shacks."

Finally, for completeness, one should comment that rotation is the only practical near-term way of providing artificial gravity. Continuous acceleration is possible—but to do it for any significant length of time requires far more propulsive energy than we will have available in the next 50 years or so.

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The turn-on-a-switch artificial gravity field of some science fiction isn't a realistic prospect because of the astronomical amounts of energy needed to curve space-time. To a first approximation, to levitate *with gravity* you would need as much energy as one would get from annihilating a mass big and concentrated enough to pull you up with the requisite force—and that assumes someone comes up with a practical way of generating such a gravity field! Clarke's law about sufficiently advanced technology being indistinguishable from magic doesn't work in reverse—not all imagined magical events can be mimicked by sufficiently advanced technology.

However, ordinary magnetism can *mimic* gravity at high enough field strengths (circa 100 Tesla). At that strength, the field distorts orbiting electrons enough to make the atoms of one's body respond to the field—thus the floating frogs we've seen in the news. But magnetic fields that strong raise all sorts of other medical issues, the equipment needed to generate them is very heavy, and this shouldn't be considered a near-term prospect. Still, such remarkable work has been done with super strong and superconducting materials in recent years, that one is hesitant to rule out anything that is physically possible. Perhaps future space stations will come equipped with magnetic "hypergee" chambers as well as hyperbaric chambers.

Going Home?

Much has been made of the difficulty of readjusting to Earth gravity once someone has been in a low *g* environment for a long time. Various authors have described later lunar and Martian generations as being long, thin, and unable to return to Earth. This seems unlikely.

Animal experiments (mainly on young mice) indicate rate of bone growth/lengthening is, if anything, *decreased* in microgravity, indicating the mice would eventually be smaller/shorter than normal. As described previously, bone growth is stimulated by the mechanical stress produced by constant movement in 1 *g*. In a child, prolonged exposure to less than 1 *g* would most likely result in reduced final length of long bones (e.g. femurs)—thus, they'd be shorter than they would have been if they'd grown on Earth.

That might apply if you could keep children from being as physically active as possible. But a culture that encourages them to play at sports and engage in contests up to the limits of their individual abilities might have children who do grow to their genetic potential, whatever the ambient gravity field. Indeed, low gravity may literally be a life-saving prescription for people who, because of some condition, cannot exercise well in Earth's punishing 1 *g*.

Can people who have been in reduced gravity for years, or born there, safely return to Earth? Well, we know that, as long as proper exercise countermeasures are taken, they can return after a little over a year in microgravity. We can't be absolutely certain that they can do so after being in space for longer than that until some-

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one actually does it. However, it's reasonable to assume that, with vigorous exercise, the 15-20 percent loss of preflight musculoskeletal mass seen during year-long missions won't worsen during longer stays in space. This is a caution for the returnee as the osteoporosis of aging is for senior citizens–but should not *prevent* return.

The caveat on this, however, is that the effects could well be more significant on growing children or an adult unable to exercise (e.g. due to a severe injury or illness). If a crew member was injured too severely to exercise for an extended period (e.g. on a mission to Mars), the musculoskeletal system might deteriorate so severely that re-adaptation to Earth gravity would be difficult–and an appreciable amount of this deterioration could be permanent.

But even then, proper care (e.g. a graduated program of physical therapy and exercise, nutritional support with calcium or agents like calcitonin, etc.) after return to Earth should give them an adequate margin of safety for normal life activities against the risk of broken bones or vertebral compression fractures.

The adverse effects of prolonged low gravity on muscles and internal organs should be even less of a problem. The cliché that someone can't come back to Earth because "their heart is too weak to stand it" seems much more fiction than fact. Again, with proper precautions any cardiovascular stresses should be relatively mild in anyone without severe underlying cardiac disease to begin with (e.g. coronary artery disease).

Finally, a combination of pharmacological interventions, exercise, and gradual adaptation in low (e.g. lunar) *g* may prove effective where individually they wouldn't be sufficient.

Radiation

Space radiation has long been a serious concern, dating back to the late 1940s in the case of cosmic radiation. Electromagnetic radiation–gamma through X-rays–is produced by the Sun and, secondarily, by reactions involving electrons and atomic nuclei. Electrons, produced by the Sun as part of the "solar wind" or from nuclear reactions, are primarily present in the Van Allen belts. During solar minimums, the Sun produces relatively low-energy protons which are also trapped by these belts. Higher energy protons (10 to 500 MeV) are produced during solar particle events (SPE). More energetic (up to 2 GeV) protons, alpha particles, and heavier ions originate outside the Solar System (possibly from ancient supernovas) and, to a much lesser degree, from the Sun as cosmic rays. Energetic neutrons, produced from nuclear reactions between protons and the atoms of the spacecraft or even the astronauts themselves, are also present.

Exposure to radiation can injure or destroy human cells by damaging DNA, enzymes, and cell membranes. How an individual is affected depends on the type and total dose of radiation received; the time over which a given dose is delivered; how it's delivered (all at once or in fractions separated over time); and the ra-

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table 1. acute & delayed effects of whole-body radiation

Radiation Dose	Primary Cells Hurt	Symptoms and Signs	Latency	Outcome
Acute Effects				
<50 rads	White blood cells and platelets	None. Mild, transient decrease in white blood cell and platelet counts. Fall in sperm counts.	1 day	Survival—100%
50 to 150 rads (Prodomal Syndrome)	Skin, white blood cells, gastrointestinal tract	Redness of skin, fever, nausea, vomiting, weakness, cramps, diarrhea, hair loss.	Hours	Resolution of symptoms within 48 hours (hair loss delayed for 3 weeks). Survival—nearly 100%.
150 to 400 rads (Hematopoietic Syndrome)	Bone marrow	Prodromal syndrome, plus anemia, skin rash, mouth ulcerations, bleeding, infection. Marked fall in white blood cell and platelet counts.	3 to 4 weeks	Three week asymptomatic period after Prodromal syndrome, then anemia, etc. Death rate—5 to 50%. May need bone marrow transplant.
400 to 800 rads (Hematopoietic/ Gastrointestinal Syndrome)	Bone marrow and gastrointestinal tract	Prodromal and Hematopoietic syndromes but more severe, with vomiting and diarrhea.	1 day	Death rate—50 to 90% within 6 weeks even with intensive treatment.
800 to 2000 rads (Gastrointestinal Syndrome)	Small intestine	Prodromal syndrome, plus bloody diarrhea, loss of appetite, infection of the intestine and septic shock.	4 to 6 days	Death rate–virtually 100% within 2 to 2.5 weeks
≥ 2000 rads (Central Nervous System Syndrome)	Brain	Prodromal syndrome, plus headache, apathy, tremors, unsteady gait, convulsions, coma.	Minutes to hours	Death rate—100%, usually within several days
Delayed Effects				
No threshold for cancer risk. Increasing acute and lifetime doses associated with increasing risk.	White blood cells, thyroid, breast, lung, bone, skin, etc. for cancer. Lens of eye. Sperm and ova.	Variable for cancer. Cataracts. Infertility. Genetic defects in offspring.	Months to years	Latent period varies from 4 to 10 years (leukemia) to up to 25 years (thyroid and breast cancers).

One rad (radiation absorbed dose) is equal to 100 ergs of absorbed energy in 1 gram of a particular material. Rem (radiation equivalent man), a unit which quantifies radiation effects in human tissue, is equal to rad X a quality factor (Q). The value of Q varies from 1 for X-rays, gamma rays, and most electrons and protons, to 10 for neutrons and 20 for alpha particles. It applies only to delayed and not acute effects.

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diosensitivity of different tissues and organs. Rapidly dividing cells like those which produce blood cells in bone marrow or line the walls of the intestines are most sensitive to injury. If damage to these sites isn't too severe, given enough time new cells will grow there. Highly differentiated cells like those of the brain are more resistant, but have little or no capacity to regrow.

Cells not destroyed outright by radiation may survive with damage to DNA and chromosomes. If damage is too widespread, the body's ability to repair or destroy these abnormal cells is overwhelmed. These mutated cells can cause cancer and genetic defects in offspring. Some individuals resist this kind of damage much better than others, suggesting gene therapy might be feasible for increasing radiation tolerance in human space travelers.

Table 1 lists the initial and delayed effects of whole-body radiation exposure. LD_{50} (50 percent of people exposed to the dose will die) is 350-400 rad. However, except for extremely high doses (>1000 rad), death is delayed for a week or even months. The most immediate problem for someone in space, especially if they're confined in a space suit, is that doses > 50 rad usually produce vomiting minutes to hours after exposure, followed soon by diarrhea and dehydration. As for delayed effects of radiation (e.g. cancer), both somatic and genetic risks increase linearly with both the level of acute doses, and the total amount of radiation received during one's lifetime. No dose of radiation is known to be completely safe from these effects. Finally, these effects are stochastic over a wide range–the risk in any particular exposed individual can only be expressed as a probability, and not a certainty.

Astronauts are classified as "radiation workers," and radiation limits are set for both specific missions and for an individual's career. Current NASA limits for radiation exposure during LEO missions are shown in Table 2. By comparison, maximum allowable annual radiation exposure is 0.1 rem for the general population and 5 rem for terrestrial radiation workers. Maximum astronaut career limits are based on a 3 percent greater lifetime risk of dying from cancer relative to the general population. They are lower in younger and female astronauts due to their longer "expected" life span, and thus more years for cancer to eventually develop.

Earth's atmosphere and Van Allen belts shield us and, to a large degree, astronauts in LEO from most of the ionizing radiation that pervades interplanetary space and airless bodies like the Moon. The Van Allen belts are areas filled with charged particles (mainly electrons and protons) trapped by Earth's magnetic field in two ring-shaped regions at an altitude of about 3000 km and 15000 to 20000 km. However, in one area near Brazil (0° and 60° west longitude and 20° to 50° south latitude, the "South Atlantic anomaly"), the inner belt descends to about 200 km. Most of the radiation received by the Shuttle results from passing through this region, which it does for 6 of 15 of its daily rotations around the Earth in a typical orbit of

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table 2. current nasa radiation exposure limits (in rem) for low earth orbit missions

	Blood-forming organs (5 cm penetration)	Lens of eye (0.3 cm penetration)	Skin (0.1 cm penetration)
Exposure period			
30 days	25	100	150
1 year	50	200	300
Career limits			
Age 25	150 (Male) 100 (Female)*	400 (Male or Female)	600 (Male or Female)
Age 35	250 (Male) 175 (Female)	400 (Male or Female)	600 (Male or Female)
Age 45	320 (Male) 250 (Female)	400 (Male or Female)	600 (Male or Female)
Age 55	400 (Male) 300 (Female)	400 (Male or Female)	600 (Male or Female)

*Career limits are lower for women largely due to gender-specific increased risk of breast cancer, and longer average life expectancy.

28.5° inclination. Overall, reported daily exposure to astronauts in LEO ranges from 3.6 to 107.8 mrad/day. The total radiation dose received by cosmonauts on a 366 day mission on Mir was 7.6 to 8.7 rad, or 12.2 to 14 rem.

Extravehicular activity and SPE increase radiation exposure. The latter typically occur at their most violent within 4 years of a peak in the Sun's 11-year sunspot cycle. They're associated with some but not all solar flares. They can last hours or days, and could expose an inadequately shielded astronaut in interplanetary space to a potentially lethal dose of hundreds of rem.

Cosmic rays of extrasolar origin present a serious problem to spacecraft venturing away from Earth. Due to their high energy, shielding that provides adequate protection from solar particles isn't effective against them. Though the rate of the radiation exposure they produce is relatively small, it's constant, and cumulative doses during long voyages in interplanetary space may be high.

Flashes of light can also be seen by orbiting astronauts due to cosmic rays striking the retina. This is disconcerting, but not considered dangerous.

Countermeasures to Radiation

Today, the primary countermeasure to radiation exposure in space is limiting the exposure time to primary cosmic rays. LEO spacecraft are lightly

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shielded. This area, below the Van Allen belts, is dominated by electrons, low-energy alpha particles, X-rays and soft interstellar gamma rays. These are stopped fairly quickly by the hull of a spacecraft, leaving cosmic radiation as the main concern. Since primary cosmic rays produce showers of particles which are energetic enough to produce more showers, it's generally better to absorb the passage of a single cosmic ray than to be downstream of a particle shower caused by its interaction with a shield atom. However, unless you're prepared to put the equivalent of two meters of water between the astronaut and the cosmic rays, you're probably better off without additional radiation shielding in LEO.

In interplanetary space, shielding astronauts from solar storm particles (mostly protons of moderately high energy) is indicated. Small, highly shielded "storm shelters" may be provided in interplanetary spacecraft. Astronauts would minimize total dose by using the shelters during an SPE and returning to the rest of the ship after it's over to minimize exposure to cosmic ray secondary showers.

Since radiation storm protons and electrons travel at sublight speed, satellite and telescope "early warning systems" can alert astronauts to seek an area with increased shielding for protection. During Apollo missions, the "Vela Hotel" satellite network, designed to detect nuclear events on Earth, acted as an early warning system for space radiation storms. A network of much more sophisticated solar observation satellites is now in place, and radiation storms can be tracked after they erupt from the surface of the sun.

Radiation dosimeters aboard a spacecraft could also be preset to sound a warning at a certain level. If there's time to reach shelter, the initial radiation levels of such a storm are readily survivable—the problem is to limit total dose.

Strong spacecraft magnetic fields may also be used to deflect charged particles. In the "Stanford Torus" space colony design, the rotating part of the torus lies within a non-rotating shell of lunar soil, several meters thick. For interstellar voyages of indefinite length, a standard cosmic ray shielding requirement of two meters of water, or the equivalent, has been proposed by Steven Howe. This may become a standard for space settlements as well.

The development of liquid-nitrogen-temperature superconductors has raised hopes that magnetic or magnetic-electrostatic shielding designs will prove practical. The greatest danger comes from protons moving at near 90 percent of the speed of light. Large superconducting current loops can create magnetic fields that would deflect incoming charged particles into miniature Van Allen belts and channel them away from inhabited parts of the spacecraft.

If this proves practical, it may have an interesting effect on spacecraft architecture which is synergistic with provisions for spin gravity—the optimum shape for crewed interplanetary spacecraft may well be a torus.

Human vulnerability to radiation may be reduced by various medical strategies, enabling us to go farther

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with less massive protective measures. Dietary (e.g. use of antioxidants) and pharmacological means for radioprotection might be beneficial. Animal studies have shown that, when injected or ingested prior to exposure, certain chemicals can increase resistance to acute radiation damage. These include cysteine, mercaptoethylamine, aminoethylisothiourea, immunomodulating agents (e.g. glucan), phosphorothionates, and even vitamin E. One of these agents, designated WR-2721, increases LD_{50} dose by 20 percent when given orally. Unfortunately, undesirable side effects (vomiting and low blood pressure) limit its use in space.

The long-term risk of radiation-induced cancer might be reduced with low doses of WR-2721 (or its active metabolite, WR-1065), dimethylsulfoxide, thiophosphorates, and vitamins A and C. However, the effectiveness and risks of these agents in humans exposed to the space environment is still unknown. Prophylactic doses of known cancer-fighting drugs, too low to produce unpleasant side effects, might be appropriate for some missions. Hypoxia (reduced amount of oxygen reaching body tissues) is also radioprotective, but comes at the expense of decreased ability to think and exercise.

There are many life forms on this planet far more radiation-resistant than humans. In the far future, when we understand the how and why of their radiation resistance, we may be able to add their strategies to our own genes.

Conclusions

The field of space medicine is still in its infancy. In overcoming the challenges of medical care in space, as always many devices and techniques will be invented that will help medicine on Earth as well. In the near future the most important areas of research will involve increasing the human body's resistance to radiation damage and the most serious detrimental effects of reduced gravity, particularly musculoskeletal deterioration and increased vulnerability to infections.

The prognosis is hopeful. Current data support the view that a healthy adult can stay in space for prolonged periods (i.e. for years) and return to Earth with a reasonable margin of safety. Future advances will add to that safety.

Living in and traveling for long times in space are and will remain hazardous occupations, as Tsiolkovsky knew well. But, as he also knew, humanity "cannot live in a cradle forever." And while life is more complicated and dangerous after one leaves the cradle, it becomes infinitely more rewarding too. ■

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*The Journal of the British Interplanetary Society

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H. G. Stratmann

THE HUMAN TOUCH

Any resemblance to reality is purely . . . extrapolative!

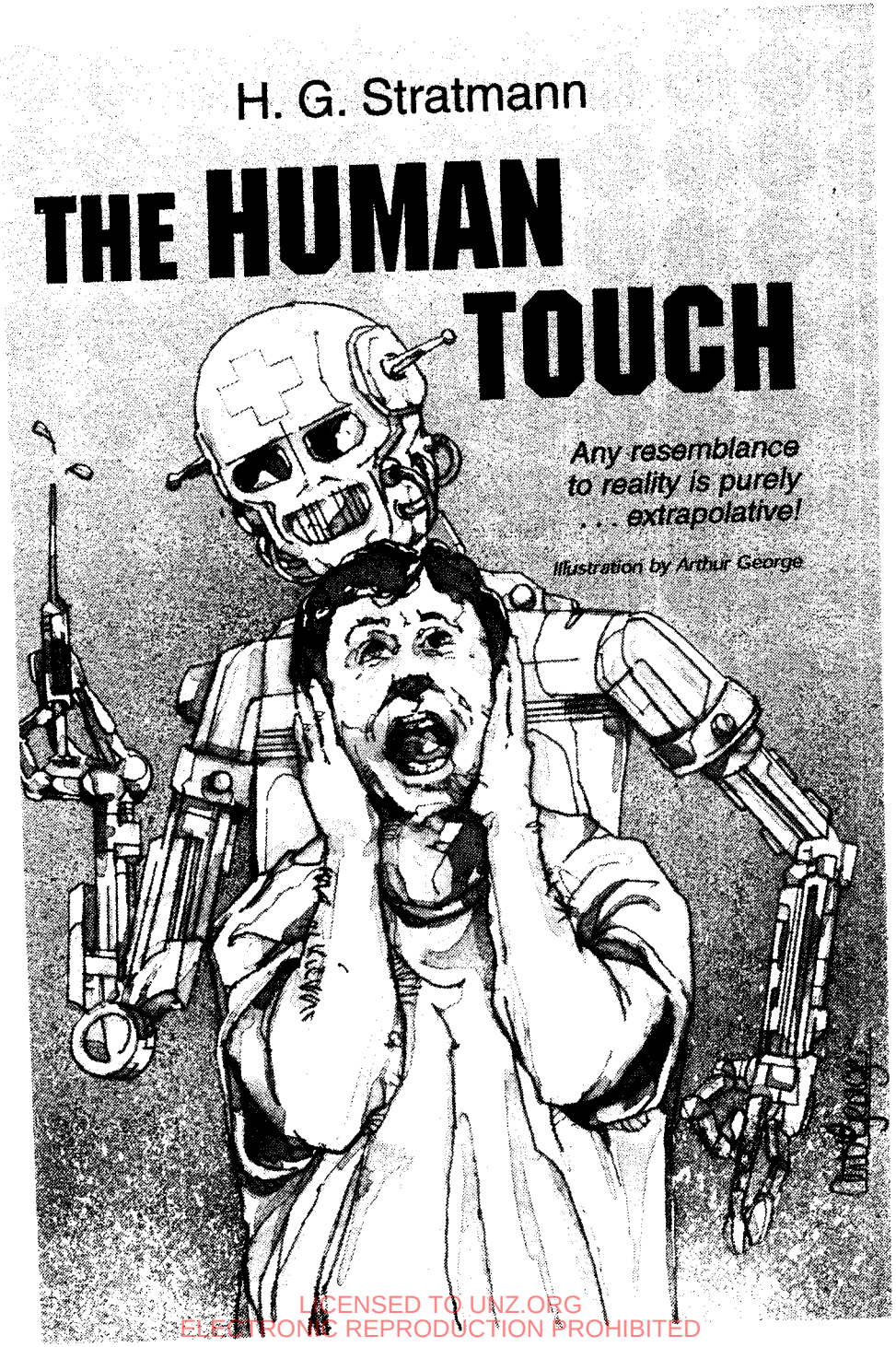

Illustration by Arthur George

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"Congratulations, Mr. Jackson! You've won—*a trip to the hospital!*"

William M. Jackson, attired in tattered shorts and sweat-stained T-shirt, gurgled, "Wha—? Who—?"

The man standing in the open doorway of Jackson's apartment grinned at him with pearly shark-like teeth. He had blow-dried white hair and wore an expensive custom-made suit. Fastened to its lapel was a gold badge with the legend "Hospital Administrator."

The administrator turned toward the Mobile Unit squatting beside him on hidden wheels. The MU, a meter-wide metal hemisphere resembling a spider, pointed a holocamera at him with one of the many tentacle-like appendages protruding from its "body."

"Yes," he told the camera. "William M. Jackson has won a trip to St. Dismas Hospital to have the operation of his dreams. The painful illness he's suffered with so long will soon be cured. Would you tell our millions of viewers what that excruciating condition is?"

Jackson muttered a word.

"Could you speak louder?"

"*Hemorrhoids!*"

The man chortled, "Hear that, viewers? Soon, courtesy of the skilled staff at St. Dismas, Mr. Jackson will no longer suffer the heartache of hemorrhoids. He'll be able to lead a happy, healthy—perhaps even productive life!"

The administrator continued with a glowing paean to the superlative quality of medical care at St. Dismas. Jackson absent-mindedly rubbed the burning spot deep in the seat of his pants before noticing the MU's holocamera was now pointing at him.

The man handed him a small plastic card. "As hospital administrator of St. Dismas, I'm proud to present Mr. Jackson with his passport to better health. Using the access code printed on this card will let him schedule the operation of a lifetime! Viewers, check your insurance plan to see if *you* qualify for care at our hospital. Or do what Mr. Jackson did—enter our weekly lottery for a free operation! Either way, remember our motto—'If you want to get good treatment at St. Dismas, you have to be sick!'"

The holocamera blinked off. The administrator shook Jackson's hand. "That recording will be downloaded to the Net today. And once again, congratulations! As one of our lucky winners, your stay at our hospital will be completely free. Except, of course, for incidental expenses your insurance plan doesn't cover. We're looking forward to having you as our guest soon!"

The man and his MU disappeared around the corner. Jackson closed the door and examined the administrator's card. It showed a holo of a gleaming white building and the words "For a good health time, access this number!"

He sat on his couch, squirming uncomfortably until he found a position that made the burning better. *First time I ever won anything in my life. And it has to be this!*

Well, he shouldn't complain. Outside of being born in one, he'd managed to get to age thirty without needing to go to a hospital. Hadn't even seen a doctor since a routine exam in high school. Never really been sick a day in his life.

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Until the hemorrhoids.

They were an occupational hazard. His fellow programmers, sitting entranced for hours at a time linked with artificial intelligence systems, got them too. Yes, the company health plan covered treatment for them. But there was a catch. They put your name on a waiting list to visit a doctor. And last time he checked, they estimated it'd be a year before he could see one.

At first he hoped the hemorrhoids would go away on their own. But they only got worse, interfering with his ability to concentrate at work. The human resources AI said he could switch to another company-approved health insurance carrier like Black Crescent, or a medical syndicate like Docs "R" Us, Inc. But their waiting lists weren't any shorter.

He'd resigned himself to months of misery when he'd found that notice on the Net. *Do long hospital waiting lists make you ill? Dying to get an operation? Enter our contest for a free stay at St. Dismas! Hundreds of winners every month!*

And he'd got lucky. Must be a public relations gimmick to get satisfied people to spread the good word about the quality care they got at the hospital, and encourage others to go there too.

Staring at the number on the card, he linked with the Net through the AI interface in his apartment. One perk of working as a programmer for Cybergates was they gave you a free cerebral implant. At first he'd been leery of having one of the new "living" chips inserted under the skin at the back of his neck. The thought of it "growing" fibrocrystal nanotendrils programmed to bore submicroscopic holes into his skull, and infiltrate his brain as a fine mesh of neural nets, was frightening.

But it hadn't hurt at all—and now he didn't know how he'd ever gotten along without it. No need anymore for awkward VR hardware—voice interfaces—or even holoscreens. Now all it took was a "thought" and he could interface directly with any modern AI—"seeing," "hearing," transmitting and receiving information by direct stimulation of his brain. He wondered how the computer pioneers of the last century got anything done using keyboards and primitive pointing devices.

A millisecond later his auditory and visual cortexes produced sounds and images that seemed to originate from two meters in front of him. An initial scene of the building depicted on the card dissolved into the likeness of a grandmotherly woman seated at a reception desk. The bespectacled holosim smiled at him.

"Congratulations on winning a free stay at St. Dismas, William N. Jackson. I hope you'll take advantage of our offer to come here. To encourage you to do that, we'd like to conduct a brief interview. Is your sexual preference for women, men, or both?"

What? Startled, he stammered his answer rather than thinking it. "Women."

The image changed again. Jackson's lower jaw dropped.

The sexy young blonde standing in front of him was all his secret fan-

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tasies wrapped up into one bodacious bundle of feminine pulchritude. Tall, statuesque, with violet eyes and ruby lips eager to devour him. She wore a small white nurse's hat, and a creamy curve-hugging skirt that ended just below her waist. Her fulsome bosom tried mightily to escape the low-cut front of her uniform.

"*Hello*. I'm Nurse Colette. I get *so* lonely here. I'd love you to come to St. Dismas so I can take care of your *every* need!"

Entranced by this angel of mercy, Jackson yielded to her sultry requests for his insurance policy and credit card numbers, and the name of his next of kin. Finally Colette purred, "When can you come see me here?"

"Uh—the 13th?"

Colette smiled invitingly. "Wonderful! I can't wait till you get here! I'll do *everything* I can to satisfy you! Bye now!"

The link ended. Jackson exhaled slowly. Strangely enough, his hemorrhoids weren't aching anymore.

He squirmed. But a neighboring area was

"How do you like our hospital?"

Jackson frowned at the hospital administrator. "It's not what I expected."

When he'd arrived at the hospital that morning an ebony-colored MU escorted Jackson down a long dark hall lined on both sides with identical gray rooms. Each consisted of windowless solid stone walls four meters on a side, except for a single wall and locked door made of crisscrossing steel bars facing the hall. They were furnished only with three crude wooden bunk beds and a bare odoriferous toilet.

Jackson lay on the bottom of a bunk bed in one of these chambers the MU called "mini-wards." The four men crammed into its other two bunk beds stared dazedly at the crumbling plaster ceiling or mumbled to themselves. His own bunkmate—easily 200 kg—snored heavily in the bed above him. Jackson glanced up nervously at its precariously sagging mattress.

The administrator smiled. "You're not the first person to tell me that. Most people expect to see some kind of white-tiled temple of healing, with doctors and nurses bustling about. There are still a few hospitals like that—but they'll soon be as extinct as dodos. What you see here is the wave of the future!"

Jackson scratched his back. The coarse paper hospital gown the MU gave him when he arrived felt like it contained splinters. The machine had also made him remove every stitch of his own clothes—and no matter how he tried to secure it, the back of the gown kept popping open.

"By the way, where are your nurses? I haven't seen any yet." *Especially Colette—*.

"Oh, we don't have any human doctors or nurses here anymore. You have no idea how much it cost to pay their salaries. Plus, being only human, they made mistakes. Doctors thought they were infallible, and never admitted it when they made an incorrect diagnosis or prescribed the wrong treatment. Besides, everybody knows they were more interested in their golf games than what happened to their patients.

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"And nurses—they just sat at their stations gossiping or reading romance novels. When a patient tried to call one, like when they were dying, the nurse often wouldn't answer because she was giving private anatomy lessons to some stud intern in a linen closet."

The administrator shook his head. "No, our new system is much better." He pointed to the MU guarding the door of the mini-ward. "Our Mobile Units are programmed to perform with cybernetic perfection all the functions human doctors, nurses, and medical technologists used to do haphazardly. You'll be astounded by the way our MUs treat you. After our MUs are through with them, none of our patients ever complain about them again! We even have 'specialists,' like the one who'll be doing your surgery."

"You mean a *machine* is going to operate on me?"

The administrator chuckled. "It's amazing how often I get that reaction from people. The neural nets in our MUs contain far more medical information than any poor human doctor's brain could hold. Even the finest flesh and blood surgeon's fingers are like baseball bats compared to the dexterity microservos and plastisteel joints give our MUs. Who would *you* rather have doing the operation—some ham-handed butcher, drowsy and hungover after partying at a country club last night? Or an indefatigable MU a thousand times more skilled?"

"Well, if you put it that way.... But I was hoping to have a nurse take care of me. Like the one I saw—."

The administrator grinned knowingly. "You mean Colette. Sorry to disappoint you, but she's not a nurse."

"Don't tell me she's such a holosim!"

"No, she's a real person. An—'actress'—who's very good at playing a nurse. And she does work here. Perhaps you'll see her in the hall."

Jackson grunted. At least that was *something* to look forward to. He glanced up at the mattress hanging over him like the sword of Damocles. The thin wooden slats it rested on had buckled several more centimeters . "Do you have any *private* rooms?"

"Your present accommodations are covered by your health plan, and are free. For a nominal fee, however, you can get a private room. Only 250 newdollars a day."

"Two hundred fifty newdollars! I thought this was all supposed to be paid for—." As his rotund bunkmate shifted in his sleep Jackson heard a cracking sound above him. "OK, I'll pay it!"

The administrator glanced at the nearby MU. It said, "Authorization by William N. Jackson to pay additional fee recorded."

Jackson said, "That's William *M.* Jackson. Also—no offense, but the way your hospital's laid out, it almost looks like a—prison."

"Actually, that's what St. Dismas was before it was converted into a hospital several years ago. The grounds look so much cheerier since we tore down the outside walls and guard towers, and removed all that unsightly barbed wire."

The administrator beamed proudly.

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"In fact, I was the warden!"

"Isn't this nicer?"

The administrator stood at the foot of the bed in Jackson's new quarters. "You're lucky this room was available. The previous occupant is, ah, no longer with us. In the old days we used it for solitary confinement. Or as part of our death row."

Jackson grimaced, shifting uncomfortably on the bed's lumpy rock-like mattress. Though the walk-in closet in his apartment was larger than this room, at least he didn't have to worry anymore about being crushed.

An MU rolled into the cramped room. The administrator said, "With all the moving around you've been doing, you haven't had your history and physical examination yet. That's usually done by an experienced MU. However, none of them are available now. I hope you don't mind if one of our student MUs does it."

"A 'student'?" Jackson glanced at the waiting machine. "Don't all your units have the latest bidirectional neoadaptive logic subroutines in their AI's, so they can understand and respond to a new situation nearly instantaneously?"

"No, the methods our MUs use to learn involve 'reinforcement learning' and 'quasi-fuzzy logic.' Those are fine, traditional methods—but require each unit to repeat the same or similar experience many times before it reaches maximum efficiency. Our 'students' must do hundreds of patient histories and physicals, and prescribe medications and perform surgery during a long training period under the supervision of senior MUs before they're allowed to work independently."

Jackson frowned. The man apparently wasn't aware he was a programmer. "But nobody's made AI's using those methods for years! That means your MUs contain obsolete modules!"

"'Obsolete' is such a harsh word. 'Classic' sounds better. Even if these units aren't the latest models, I'm fully confident of their reliability. Besides—I was able to buy them wholesale at an excellent close-out price."

The administrator turned to the MU. "Show him how proficient you are."

The MU said, "Hello, William N. Jackson. I am Mobile Unit ICD-9."

"That's William *M*. Jackson. M, as in Marvin."

The student ignored him. "Would you please tell me what problem brought you to the hospital?"

"Hemorrhoids."

The MU processed that datum. "Chief complaint: This patient's a pain in the butt."

The administrator shook his head. "No, that's wrong. He *has* a pain in the butt."

The MU scrutinized Jackson carefully, its optical sensor swiveling at the end of a long flexible metal rod extending from its body. "Looks to *me* like he's a pain in the butt!"

"Hey, what's wrong with this thing—!"

The administrator shrugged. "A slight glitch in its programming."

The MU raised an appendage fitted with a hot bright light and shone it into Jackson's blinking face. Then it grilled

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him with an incessant barrage of questions about his medical history.

"Where are your hemorrhoids located?"

"Where do you think!"

"What does the pain feel like?"

"It hurts!"

The MU's interrogation became progressively more irritating. Why, Jackson wondered, was it important whether his great-aunt Minnie had constipation? He'd balked when the MU asked him to give detailed accounts of every sexual encounter he'd had in his entire life. The embarrassing thing was—there wasn't much to tell. Eventually, persuaded by the administrator's assurance such information was confidential and necessary to provide him with the best medical care, he relented.

Finally the MU said, "Now it's time for your physical examination."

Immediately a series of snake-like tentacles telescoped from its case holding dangerous-looking instruments. Several other appendages grabbed Jackson and lifted him off the bed. The next few minutes were a blur of dazzling lights shining in his eyes, tubes thrust in his ears and nose, and reflex hammers making his arms and legs jerk like a marionette's.

Take a deep breath. Does it hurt when I press in like this? Turn your head to one side and cough. Disobedience was punished by sharp electrical jolts to sensitive areas. After checking his front side, the MU flipped him over like a flapjack and checked the other. Then it plopped him back on the bed.

"Overweight," it reported. "Flabby muscles. Unremarkable male genitalia. But general health appears good."

The administrator frowned. "I didn't see you check him for hemorrhoids."

The machine ruminated on that. "Oops."

Two appendages grabbed him again and rotated him onto his stomach. Turning his head, Jackson saw the MU extrude a new sinuous tentacle—a thin glistening pink cable. It looked like the tongue of a ravenous anteater, and was headed toward his—.

The administrator nodded approvingly at the thorough, in-depth examination the MU was performing. "Excellent! It's really getting to the *bottom* of things, isn't it, Mr. Jackson?" Then, disappointed at the patient's vehemently vulgar reply, he continued, "I'm sorry you don't appreciate tongue-in-cheeks humor."

After the administrator and his torture machine left, Jackson couldn't sit on the bed without wincing. That *$%*@ "student" had a lot to learn about bedside manner!

His room was completely bare except for the bed. They'd taken his watch when he'd arrived, so he had no idea how long he'd been here. Searching with his implant for a nearby AI interface terminal produced no results. There had to be some elsewhere in the hospital, but they must be over ten meters away—out of range of his implant.

Utterly bored, he decided to go for a walk in the corridor outside. But he'd barely risen from the bed when an MU rolled up, blocking the doorway.

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"I'm sorry, William N. Jackson. Patients must stay in their rooms to avoid interfering with our work or disturbing other patients."

"That's William *M.* Jackson. M, as in—oh, never mind. Isn't there anything I can do while I'm waiting to get my operation? I'm going crazy sitting around like this!"

"For a nominal fee, a psychiatrist MU can do a consultation on you. It's equipped with injectable psychotropic drugs, equipment for electroshock therapy—."

"No, no, that's just a figure of speech! What I mean is, could you get me a portable interface, a holoprojector—even just something to read?"

"For a nominal fee, you can rent an entertainment cart. Only 500 newdollars."

"Five hundred! That's robbery!"

"The cart contains printed and audiovisual material. Do you authorize us to charge you for it?"

"You can shove it up your—oh, all right! Better than going stir-crazy here!"

The unit returned pushing a rickety cart with squeaking wheels. One of its shelves held moldy yellowed newspapers. A headline proclaimed, "Elvis Clone Marries Alien Bigfoot Princess!" Jackson snorted. *Really* old news. Happened twenty-five years ago. That particular clone was now a grandfather.

The MU zoomed away without explaining how to work the archaic electronic equipment atop the cart. They resembled devices he'd last seen in kindergarten. A "TV" and—what'd they called it—a "BCR."

Turning the TV on produced only crackling static. Then he found a mysterious rectangular object several centimeters thick made of black plastic. It fit perfectly into the slot on the front of the BCR.

Suddenly two-dimensional moving pictures limited to shades of gray appeared on the TV. The program it showed was a historical drama—mid-20th century by the look of the clothes and vehicles. A voluptuous young woman became distraught after realizing she'd developed an alarming health problem. She contacted her doctor, who told her to come to his office immediately. Instantly she was in his examining room, tantalizingly dressed in a diaphanous gown. Two men in white coats finished their examination and looked at her gravely. The handsome younger doctor's eyes betrayed more than medical interest in her body as his white-haired mentor informed her she had a very serious disease. It had an ominous Latin-sounding name which clearly implied she wasn't long for this world. Jackson was startled to see the patriarchal physician sympathetically explaining his findings bore an uncanny resemblance to the hospital administrator.

The rest of the program detailed the two physicians' intense efforts to help the woman. The younger spent all his time comforting her, lending his broad shoulders for her to cry on. Soon their feelings for each other blossomed into a tragic love—her illness obviously prevented them from consummating their relationship. Meanwhile the older doctor labored to help her in his own way, searching for weeks through the latest medical

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journals and textbooks in that primitive pre-PC age—trying desperately to see if researchers had finally discovered a cure for her painful condition.

Then, when all seemed lost, he found it. Back again in his office, the woman sobbed gratefully as the senior physician gave her the good news. The treatment he'd prescribed had completely cured her severe case of pediculosis pubis! At the final fade-out, the coy looks exchanged between the woman and the younger doctor indicated that, her cure complete, their relationship would soon become more than platonic.

Jackson gazed yearningly at the smiling elderly physician on the TV, and wiped tears from his own eyes. *Why can't I get a doctor like that?*

After turning off the TV, Jackson felt his stomach gurgle noisily. As an MU skittered by his doorway he called, "When's mealtime?"

The unit stopped, and ejected a small object which struck him lightly in the chest. It was a bag of honey roasted peanuts. They were stale, but better than nothing. He'd gulped the snack down before noticing the "Best if used by" legend on the bag was dated two years ago.

The MU said, "May I have the bag, sir? The hospital gets a newdollar for every hundred we send back for recycling."

"Here! Now when do I get a meal?"

The MU whirred softly. "That *was* your meal, sir."

"*What!*"

"For a nominal fee, we can provide you with a more filling meal. Only 1000 newdollars. Do you authorize payment?"

"Hell, no! I'd rather starve to death than pay that much for a meal!"

"*Starving* to death takes many days, sir. For a nominal fee, I can have a kevorkiologist MU come and make the process nearly instantaneous."

"No! That's not what I meant!"

The MU's optical sensor moved menacingly toward his face. "Which would you like me to bring, sir—the kevorkiologist, or a meal?"

The tone in its voice indicated those were his only two choices. "The meal . . . ."

What it brought looked like baby food. Each recessed compartment of the rusty metal tray contained an unidentifiable pureed "delicacy" colored bright red, green, or blue. The "nominal fee" for a spoon was a bargain—100 newdollars. Though the meal smelled and tasted like something died in it, he ate every bite. Partly because he was hungry. But mainly because he thought it might be his last.

Afterwards Jackson tried to sleep. But every time he dozed off a new MU woke him up.

Time to check your vital signs, sir.

Would you like a sleeping pill, sir?

I need a blood specimen, sir. Here's your do-it-yourself venipuncture kit. Or, for a nominal fee of 1,500 newdollars, I can draw it for you.

Need a bedpan, sir? Only 2,000 newdollars—and the first piece of toilet paper is free.

Once, Jackson thought he'd gotten the better of one of those damnably polite machines. The meal he'd eaten

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earlier was giving him heartburn. Informed of his distress, an MU asked if he'd like some medicine for it.

Jackson snatched the white pill the machine offered him and quickly swallowed it.

"The charge for the pill is 500 newdollars, sir. Do you authorize payment?"

Jackson grinned triumphantly. "No, I don't! What're you going to do about it?"

Immediately the MU shot a half dozen appendages toward him, holding his head and prying his jaws open. As another tentacle clutching what looked like a garden hose moved toward his mouth, Jackson gurgled "I'll pay!"

The appendages retracted. "A wise decision, sir. There would've been an additional 1,000 newdollar charge for suctioning your stomach."

Jackson cringed when the next MU entered his room. "Sir, I need to take you to the X-ray department."

Jackson smiled. At last he was going to leave his cell, if only temporarily!

The dark dirty corridor outside was filled with scuttling MUs. White ones with "Medical Device," "Data-processing Observer," "Robotic Nurse," or "Laborsaving Programmable Nurse" printed on their sides. Red ones, like the unit that had sucked blood from his arm, labeled "Hematologic Mechanical Operator." Blue ones like the MU taking him to X-ray—"Cybernetic Medical Technologists." And ominous black ones—"Digital Restraining Guards"—escorting other worried-looking patients.

A rickety elevator took them down to the ground floor. The MU led him into a large room containing ancient, ceiling-high machines covered with dials and switches. A portly man dressed in a blue scrub suit stood frowning in front of the equipment. Jackson glanced at his own flimsy paper gown, then enviously at the man's uniform.

The MU addressed the man. "He needs a chest X-ray."

"OK! Would you please step over here, Mr.—?"

"Jackson. William M. Jackson."

"Press your chest against this plate while I put the X-ray camera behind you."

As Jackson complied the MU said, "I'll return shortly to escort you back to your room."

After it trundled off Jackson muttered, "Don't hurry." Then, to the man, "I was beginning to think this place didn't have any human beings working here. Just machines."

The man walked to a control panel. "Oh, I don't work here. The MU that normally operates this equipment is being repaired, so they asked me to fill in for it in exchange for this neat scrub suit I'm wearing. Actually, I'm a chef—in here for gall bladder surgery tomorrow."

He twisted several knobs. "Can't remember exactly what settings they told me to use. Maybe it works like a microwave oven. Let's turn this 'kilovolt' knob over to maximum power . . . and X-ray exposure time to ten minutes. If that's not long enough, I'll just 'cook' you some more!"

The man flipped a switch. "Hey,

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Mr. Jackson, come back! You're not done yet!"

As Jackson ran out into the hallway he heard a continuous buzzing sound—followed seconds later by a muffled explosion. Glancing back, he saw smoke pouring from the room he'd vacated. Several MUs raced past him toward it, ignoring him. Taking advantage of the distraction, he crouched in a doorway while more machines passed. When the coast was clear he crept carefully down the deserted hallway. Finally, rounding a corner, at the other end of the corridor he saw something that filled him with sudden hope.

An "Exit" sign.

Hemorrhoids or no hemorrhoids, he had to escape! With his luck, the surgeon MU would be broken too—and he'd get operated on by a plumber dressed in a nice new scrub suit reading "Surgery Made Simple"!

Sneaking toward the exit, Jackson passed a closed door marked "Obstetrics." Behind it he heard a faint sharp slap and a baby cry. An MU said, "It's a boy, ma'am. Now drive down to the next window, pay your bill, and then we'll give him to you." There was the sound of a car engine starting—.

"Excuse me, sir."

Jackson froze—then turned around. The MU said, "Please follow me back to your room."

"Uh—I've decided not to have the surgery. I just want to go home—."

"I'm sorry, sir. It's our duty to ensure your health care needs are properly met."

"That's OK, I—ouch!"

His arm locked in the MU's steely grip, Jackson had no choice but to meekly comply. The elevator they entered stopped briefly on the second floor—and then he saw it. At the other end of the long hallway.

An AI interface.

Desperately he tried using his implant to link with it. Maybe he could communicate with the hospital's central AI system. Override the MU's programming so it'd let him leave—.

But it didn't work. The interface was too far away to access. The elevator doors closed, and soon he was back in his room.

The MU said, "Good news, sir! I've just received confirmation your operation is next on the schedule."

Though it didn't have a face, the machine seemed to smile. "Soon they'll be coming to take you away."

Jackson shuffled slowly down a long corridor, flanked on either side by two white MUs. A husky DRG unit followed directly behind him, blocking his only escape route as he walked the last mile—

In the operating room, several MUs laid him on his back on a hard table and dowsed his bare groin with icy brown fluid.

"Why do you have to shave off that hair?"

"I'm sorry, sir. It's necessary."

"Well, be careful with that razor. I don't want you cutting off anything down there except hemorrhoids!"

The MU tilted its optical sensor quizzically at him, then resumed its barbering.

Next they laid a large drape with a hole in its center over him. As he shivered in the freezing room, another

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MU entered. It held two long appendages raised in front of it, dripping with lubricating oil, while another unit slipped long plastic sheaths over them. The machine rolled over to Jackson. "Hello, sir. I will be your surgeon today."

"Uh—you have done this kind of surgery before, haven't you?"

"Don't worry, sir. After I'm through, you'll feel like a new person."

Another MU at the head of the table placed a rubber mask over his mouth and nose. "The anesthetic," it explained.

After a few breaths Jackson felt drowsy. The surgeon MU said, "Once you're asleep, we'll begin the operation. After making an inverted-U perineal scrotal skin incision, I will perform a bilateral orchiectomy, then complete the procedure following a deep perineal dissection."

Now barely conscious, Jackson mumbled through the mask, "Is that what you call an operation to treat hemorrhoids?"

The surgeon MU held a sharp gleaming scalpel poised over his groin. "No, William N. Jackson. The procedure I'll perform is commonly referred to as a sex change operation."

The fog in his brain cleared slowly. He was floating in the clouds, drifting slowly back to Earth, light as a thistle—

Oh my God!

Jackson snapped awake, remembering the operating room. He was back in the bed in his old room. Heart pounding, he pulled up his gown—and gasped in relief. Everything was still there.

The administrator entered the room, a concerned expression on his face. "How are you feeling, Mr. Jackson?"

"How do I feel? Your machine was going to cut off my—!"

"A regrettable error. I take full responsibility for it. Fortunately, it was caught in time."

He paused. "At least in your case. I just came from William 'N.-as-in-Nathaniel' Jackson's room. Luckily, the other Mr. Jackson happened to have hemorrhoids too along with his, ah, other condition. We've put him back on the schedule for the procedure he was supposed to have. He seemed satisfied he'll now get two operations for the price of one. Of course, we've re-scheduled your surgery too."

"If you think I'm going to let one of those machines near me with a knife again, you're crazy! I'd rather keep my hemorrhoids and get out of this hellhole you call a hospital!"

The administrator looked hurt. "I'm sorry you feel that way, Mr. Jackson. I realize our accommodations aren't luxurious, and the services we provide our patients aren't as personalized or perfect as you and I would wish them to be. But providing health care to every American consumes trillions of newdollars annually. As people live longer and expensive new medical treatments and technologies are developed, costs keep rising. Without fiscally responsible measures to manage and contain those costs, there wouldn't be enough money to give everyone basic medical care."

He smiled sadly. "Our oldest patients complain the current system is-

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n't like the 'good old days.' 'We had our own private doctors then,' they say. 'Dedicated people who really cared about us. If we got sick they'd treat us or admit us to a hospital immediately—without months on a waiting list. The doctor made sure we got the best care possible, and let us stay in the hospital as long as we needed!'"

Jackson glared at the administrator, remembering the TV program he'd seen. "Well, wasn't it like that?"

"Yes—for the few people wealthy or lucky enough to get that treatment. But there were also millions of people without health insurance or enough money to pay for medical care. Any doctors *they* managed to get were usually poorly trained or inexperienced. And I could tell you horror stories about private hospitals turning away suffering, seriously ill people or transferring them to tenth-rate government-supported medical centers because they had a 'negative wallet biopsy.' The situation became critical when the federal government finally went bankrupt a decade ago, and over a hundred million more people—the ones who'd relied on programs like Medicare and Medicaid—suddenly found themselves without affordable health care."

The administrator shook his head. "Our new system isn't perfect. But at least now everyone *has* access to health care, and is treated equally. If we must cut corners here and there to save money—well, that's a necessary sacrifice."

Jackson grumbled, "Well, you could at least try to show a little compassion for people. Your machines make you feel like a slab of meat in a processing plant!"

A trace of anger flickered across the administrator's smooth, perfect features. "I assure you, the well-being of our patients is foremost in our minds. It'd have been more economical to have only MUs here—with no human presence whatsoever. Just machines and patients. The fact I'm here, checking personally to ensure your stay is as pleasant as possible, proves this hospital's commitment to giving our patients that essential 'human touch.' Despite their technological sophistication and medical expertise, MUs look like, and are, machines—incapable of human emotions like compassion. It's understandable people feel uncomfortable trusting them with their lives.

"My primary function is to reassure patients that someone *does* care about what happens to them. Someone they can relate too, who looks just like them—flesh and blood, not just metal. Someone they think understands their anxiety, fear, and pain—and who'll share that burden with them."

The administrator folded his arms. "You don't think of *me* as a machine, but as a human being. Don't you?"

"Yes, but—."

Suddenly Jackson realized where this conversation was leading. He fearfully examined the figure standing before him. The perfectly coifed hair—each strand as fine and identical as polyester fibers. The pale forehead—smooth as tinted plastic. The curiously glassy blue eyes. The ivory teeth gleaming between delicately sculpted lips.

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He wasn't fooled by the administrator's slick, reassuring words. No *human being* could be so devoid of conscience they'd dare tell him the hospital's "cost containment measures" were really meant to help him or other patients. No *person* who'd ever been sick himself could be so lacking in human sympathy he could blatantly lie like that for whoever was lining their pockets with the money the hospital was saving.

Only an inhuman, state-of-the-art AI—an unfeeling silicon shill inside the new humanoid robots Cybergates was rumored to have developed—could be so utterly amoral!

"You—you're a machine too, aren't you!"

The administrator's hand moved toward "his" face—and Jackson had a nightmarish premonition. He imagined a thin flesh-colored mask being stripped away—revealing a hideous skull of silvery steel. The bare white globes of its eyes held steady by microservos, staring pitilessly at him. A mouth formed of porcelain teeth and naked metal grinning sardonically—.

The administrator brushed beads of sweat from his forehead. "No, I'm quite—human."

Jackson sat dumbstruck as the full horror and audacity of that admission dawned on him. The administrator continued. "If you'll excuse me, I have other duties. I hope we can talk again after your operation."

By the time Jackson regained his senses the room was empty. He leapt from the bed and glanced up and down the hallway outside, fighting an urge to panic. From far away came the muffled voices and faint whirring of MUs—but none were in sight. Moving quietly, Jackson raced down the corridor, listening. The only sound he heard was his bare feet slapping against the floor, crunching an occasional cockroach.

Not daring to trust the elevator—odds were MUs would be on it, and he couldn't outrun *them*—he sighed in relief when he discovered a sign marked "Stairs." At least he had that advantage over those mechanical monsters—steps were made for legs, not wheels.

Down one flight, then two—if he was right, what he was searching for was on this floor. The door by the stairwell was solid and thick—no way to tell if there were MUs waiting on the other side.

Panting, Jackson opened the door a crack and peeked out. Still in luck. The elevator he'd been on when he'd spotted the AI interface here on the second floor was several meters away. He threw the door open and made a desperate dash down the empty hallway towards the interface—.

Suddenly an MU appeared, blocking his path. "I'm sorry, sir. Patients must remain in their rooms until called for."

Ignoring the machine, Jackson redoubled his efforts and ran by it. But he got only another meter before being jerked to an abrupt halt as slithering appendages grabbed him around the mid-section.

"Come with me, sir."

As the MU's tightening tentacles began yanking him back, Jackson

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strained one last time to link with the device so tantalizingly close at the end of the corridor—.

Then he felt it. The familiar buzz inside his brain as his implant made contact with the AI interface. Digging in with his heels, locked in a life-or-death tug of war as the MU dragged him centimeter by centimeter in the opposite direction, he absorbed the data pouring into his brain from the hospital's central AI—and groaned. Security codes barred access to the main control programs. If he couldn't override them in another few seconds the MU would have him out of range—!

Suddenly the MU released him. It stared mutely at him with its optical sensor as Jackson gave it a swift kick—then hopped in pain after remembering too late he was barefoot. Moving closer to the AI interface to ensure he stayed linked, he considered having the MU disassemble itself with its own appendages. No—he needed it for a more important task.

As the machine skittered away Jackson delved deeper into the central AI system. Luckily, its security codes had been easy to crack. The administrator had apparently skimped on that too—probably hiring programmers just out of training who'd done a slipshod job. It was easy to make the software changes he wanted. There was more than one way to lend a "human touch" to this place. Soon it'd be like a hospital *should* be!

The MU returned from its errand. "Your clothes, sir."

Jackson thankfully stripped off his tattered hospital gown and put them on. It felt good to be dressed like a human being again.

"Anything else, sir?"

"Yes. Escort me out of here!"

Several other MUs joined him, forming an honor guard as Jackson strolled toward the exit. Soon he was out of range of the AI interface again—but it didn't matter anymore. A simple command to the central AI beforehand ensured the MUs were still under his control. The machines recognized individual human beings by scanning them with their optical sensors and correlating that data with identifying information in the hospital's database. All it took was an order to match his own image with the administrator's ID. And vice versa.

An MU, convinced the man it scanned was the hospital administrator, opened a door for him. Jackson blinked as he emerged outside into sunlight—once more, a free man. He smiled, imagining what the administrator's face would look like when the MUs gave *him* their "standard" care for patients —and took who they thought was "William M. Jackson" for his hemorrhoid surgery. Maybe he'd done the guy a favor. Maybe the administrator had hemorrhoids too. And if he didn't, at least he'd get a taste of his own medicine before the surgeon MU discovered there was nothing to operate on.

As for himself—there was still hope. Somewhere in the world there must be at least one caring, *human* doctor left. Someone like the elderly physician on that old TV program, who'd treat him with dignity and compassion. Who'd never rest until

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they'd used the accumulated medical knowledge of millennia to cure his problem. It might take years to find such a dedicated healer. But when he did, it'd be worth the wait.

Sustained by that comforting thought, Jackson hummed the theme music from "Marcus Welby, M.D." Just hearing that soothing melody again made his hemorrhoids feel better.

Epilogue

Alone in his spacious cedar-paneled office, the administrator stroked his putter. The golf ball rolled straight into the plastic cup at the other end of the carpeted floor. He laid the gold-plated club down on his expansive oak desk, settled into an exquisitely cushioned leather chair, and spoke into the intercom. "Colette, would you bring me the hospital's latest financial report?"

The door opened. Colette was wearing that exiguous nurse uniform he liked so much. A mist of pheromones swirled around her as she handed him the papers. "Would you like me to do anything *else* for you, sir?"

"Not now."

Watching his secretary undulate out of the office weakened his sense of duty. They could listen to one of the titillating recordings the MUs made of patients' sexual histories, and play their favorite game—"Doctor." But no—business before pleasure.

He smiled at the report. The Board of Directors would be pleased profits were still skyrocketing. And the percentage of them *he* got as a bonus for "containing costs" and "enhancing revenue" looked nice too.

The administrator yawned and stretched his arms. A long nap after lunch made the day fly. Time to go on rounds again. Experience had taught him to check on the inmates—correction, *patients*—periodically to keep them from making trouble. Like that one who almost had the wrong operation. He really should get the programming glitch that made MUs misidentify patients with similar names fixed. But programmers were expensive. . . .

Well, maybe next fiscal year.

He'd walked only a little way through the hospital before he stopped—horrified. MUs were skittering frenziedly through the hallways. A blur of metal appendages scrubbed floors and applied fresh paint to walls until those worn surfaces looked new. Befuddled patients milled in the corridors, tearfully accepting the expensive-looking robes and pajamas MUs were bringing to replace their paper gowns. Other MUs exchanged dilapidated beds with new ones, carefully applying clean sheets and fluffing plush pillows.

The administrator staggered dazedly—finding new horrors around every corner. Patients were being served gourmet meals—for *free*. As an MU raced past he glimpsed the label of the wine bottle on the tray it carried. It was one of the 2010s from his own private stock. He saw MUs treating patients with courtesy and basic human dignity—and worst of all, performing billable services like blood drawing and giving medicines without asking for payment authorizations! They were even knocking

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out walls, enlarging patient rooms, and putting framed windows in previously solid concrete to let sunlight in. Through one of those windows he saw MUs unloading a fleet of automated trucks delivering expensive building supplies and furniture, and the very best medical equipment and supplies. Soon St. Dismas would be a state-of-the-art hospital—and look like a luxury hotel!

The MUs ignored his screamed orders to stop, and kept at their work. Finally, faint with shock and frustration, the administrator stumbled into an empty patient room and sat on its disgustingly comfortable bed. Why were the MUs acting like this? And how much was all this *costing*?

Maybe a virus had infected the central AI. He had to get back to his office—use his private voice interface to regain control of it.

Mobile Unit ICD-9 rolled to the doorway and swiveled its optical sensor at him. "You're not in your gown, sir. That's against regulations."

The machine picked him up, ripped off his expensive custom-made suit and rubber underwear, and wrapped his bare body in a scratchy paper gown. It trundled him down the hallway so fast he couldn't speak until they'd reached the operating room.

"Don't put me on that table, I'm not a—*blurp*!"

The anesthesiologist MU held him down while it snugly secured a mask over his face and administered the anesthetic. As his consciousness seeped away, the administrator saw the surgeon MU holding a sharp gleaming scalpel over his groin.

"Don't worry, William N. Jackson. After I'm through, you'll feel like a new person."■

The whole history of civilization is strewn with creeds and institutions which were invaluable at first, and deadly afterwards.

—Walter Bagehout

The keenest sorrow is to recognize ourselves as the sole cause of all our adversities.

—Sophocles

The Golden Age was never the present age.

—Benjamin Franklin

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Amy Bechtel

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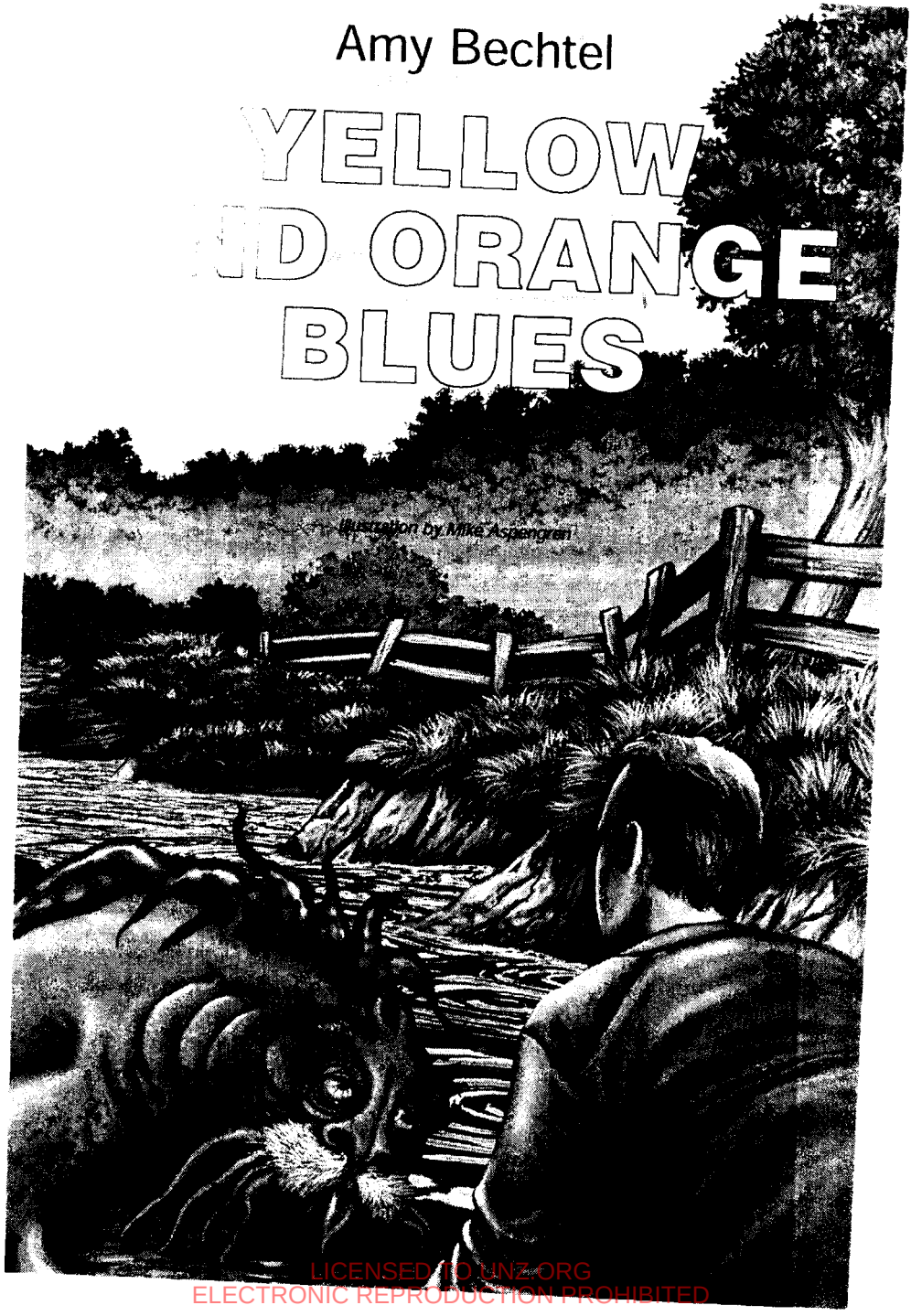

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On Wednesday Howard Winston brought a cardboard box to my veterinary clinic. I saw him sitting in the waiting room with the box in his lap, studying an open book propped across the box. An extension cord protruded from the box and coiled under Howard's chair to a wall plug; undoubtedly it was connected to a heating pad. Perhaps, I thought wistfully, Howard had an orphan puppy or kitten in the box. It would be nice to see a normal sort of animal for a change. But it was probably a reptile. I sighed and called in the next patient.

After I had seen a poodle with a cyst (the owner had thought it was a tick, and had valiantly tried to pull it off), a parakeet for a wing-and-beak trim, and an iguana with metabolic bone disease, I began to wonder if my receptionist, Kami, had forgotten Howard. I peeked into the waiting room, and at that moment Kami rushed forward breathlessly to hand me the file. It was so heavy I almost dropped it. Howard's file had always been bulky, but now—I opened it and counted—there were thirty-seven new charts in it, each painstakingly filled out by Kami. All thirty-seven said exactly the same thing: species reptile, breed desert tortoise, color green, sex unknown, age two days.

"I'm sorry the paperwork took so long, sir," Kami said, "but there were so many charts to fill out. And, Doctor Clayton, I didn't fill out the 'name' part because he hasn't named the turtles yet."

"Tortoises," I corrected.

"Oh. I'm sorry." Kami looked devastated at the correction. I was about to mention that she could have done the paperwork in 1/37 of the time by making use of the copy machine, but I didn't have the heart.

"Never mind," I said, and called Howard into the exam room. He smiled affably, closed his book, unplugged his box, and brought it in. He didn't complain about being kept waiting; Howard is the most patient man I've ever met. He also has the most bizarre collection of exotic pets I've ever seen. For him, a box of thirty-seven baby tortoises was downright normal.

"Hi, doc," Howard said cheerfully. "I've got a whole herd of Max's kids to see you today."

"Thirty-seven kids? Max gets around." Max is one of Howard's favorite pets, a huge venerable desert tortoise with a penchant for females.

"They just hatched," Howard said proudly.

I opened the box and looked in. The box was full of exquisitely tiny tortoises, no bigger than silver dollars, all busily crawling over and under each other. I picked one up and set it in the palm of my hand. It peered up at me nearsightedly, extending its little neck, and I smiled. It was a sweet little thing. Adorable, really. I had never realized that reptiles could be so cute.

Cute? What was I thinking? I was an affirmed horse and cattle vet; I only did dogs and cats because there wasn't enough large animal work to make a living in this town. I only did exotics because of Howard, and because of all the exotic pet owners Howard had

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referred to me. So how had I ended up seeing more snakes and lizards than cattle and horses? And when had I come to think of reptiles as *cute?*

I looked back at the baby tortoise in my hand; it was still adorable. It snuffled, and I held it closer. Its tiny nostrils were clogged, and its eyes were swollen partway shut. I picked up another tortoise, and another, keeping track of which ones I had examined by moving them to another box. Most of the babies had one symptom or another of respiratory disease, a very nasty thing in desert tortoises. I would need to get them all onto antibiotics. I looked doubtfully at the tiny creatures, then looked up the antibiotic dose. There was quite a bit of debate in the literature about the appropriate tortoise dose; I averaged the recommendations of several experts and then weighed a representative tortoise. The dose wasn't hard to calculate; I would need about 0.0002 cc for each baby. Measuring the dose, however, was going to be tricky. I groaned and began to calculate dilutions. I was deep into a set of fractions when Kami knocked on the door and anxiously poked her head into the room.

"Doctor Clayton?"

"Not now, Kami."

"But Doctor, it's an emergency."

The final calculation took advantage of the interruption and eluded me, and I sighed and gave up. "All right. What is it?"

"It's a dog. It needs vaccinations. The owner says it's a whole day overdue. I thought I'd better tell you."

"Oh." I closed my eyes and began to count to fifty. "Thank you, Kami."

"You're welcome." She smiled and closed the door.

Howard coughed and said, "I didn't know vaccinations were an emergency."

"They're not."

"Shouldn't you tell Kami?"

"I'm afraid to. She might decide that arterial bleeding isn't an emergency either. Do you suppose Lynda might want to come back to work?" Lynda used to be my receptionist, before she went off to live with Howard, and I missed her terribly. I missed her more every day I worked with Kami.

Howard looked doubtful. "She's awfully busy," he said.

"Figures," I said sadly. "And my kennelman is quitting next week. He says cleaning cages and stalls is too gross, and mopping hurts his back. I can't seem to keep kennel help for more than a month any more." I couldn't seem to get rid of Kami, either. Maybe I should assign her to clean some of the more revolting cages.

Howard said thoughtfully, "I have a poetry student who might be interested in the job."

"A poetry student? To clean cages and mop floors?" I threw up my hands.

"Sure."

I shrugged helplessly. "If he's interested, have him give me a call."

"She," Howard said.

"She?"

"She. I'll let her know."

"Sure." I settled back to my fractions, bemused, wondering why a poetry student would possibly want a job at a veterinary clinic.

"So how's your social life?" Howard

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asked. "Are you still seeing Susan Rose?"

I sighed. I'd gone out with the beautiful Susan Rose twice, but the third time I asked her for a date she said no (politely, but still no) and the fourth time she said no a bit less politely, which seemed to be some kind of hint.

"Oh no," I told Howard, trying to sound casual. "We didn't really hit it off. Besides, I don't think I was ever meant to date a woman who owns a pet snake."

Howard laughed. "Oh come on, Doc, you're great with snakes."

"Not with snakes named 'Terminator.'"

Actually I was not good with snakes of any kind, but it would probably be best not to mention that to Howard. He had a few snakes of his own that I might have to treat someday.

"By the way," Howard said, "could you come by our place on Friday night?"

I looked at him suspiciously. "Why?"

Howard smiled. "It's a surprise."

"What kind of a surprise?" A few months back I had given Howard a surprise of my own; I had presented him with an orphan calf which he'd then had to bottle feed night and day. I was afraid that Howard might have retribution in mind.

"Come over Friday night and you'll find out."

"You don't have a new pet, do you?" I asked nervously. If he had a new pet it would probably be a species I wouldn't even recognize.

"No new pets," Howard said, "except for these thirty-seven. So you'll come?"

"Well, I'll try," I hedged. "Depends on how things go, you know how it is."

"OK," he said amiably. "So how much antibiotic do I give the babies?"

I'd gotten distracted from my fractions again and I still had all those hideous dilutions to calculate. Why didn't anyone manufacture drugs of a suitable strength for the one-gram patient?

On Thursday Howard's poetry student came to the clinic for an interview. Thinking of a poetess, I had imagined a fragile, ethereal young woman, with long dark hair and a flowing white dress. The woman who appeared in my office wore a leather jacket, jeans, and a tattoo. Her short spiked hair was dyed a startling shade of magenta and was decorated with a bright green lizard-shaped hairpin. She smiled and said, "Hi, I'm Tegan Smith. I'm here about the job."

I stared at her for about thirty seconds before I remembered to invite her to sit down. "Er, hi," I said. "I'm Michael Clayton. Did, uh, did Howard tell you what the job involved?"

"Sure," she said easily. "Cleaning cages and mopping floors."

"And did he tell you how much it pays?" *How much* was perhaps not the correct term; *how little* would have been more accurate.

"Yes."

"And you're interested?"

"Sure. Are you?"

"I, ah—"

Something suddenly moved in her hair, and I stared.

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"What is it?" she said.

Her lizard hairpin was moving. With a switch of its tail it crawled to the top of her spiky bangs, and peered at me with unblinking eyes.

"Ah. Um. There's something in your hair."

She reached up, looking puzzled, and plucked the lizard off her bangs. "Oops," she said. "I thought I put him back in the terrarium." She patted the lizard and popped it back into her hair. Then she smiled a dazzling smile and said, "So do I get the job?"

Leather jacket, tattoo, wild hair, and reptiles: well, she would at least be a contrast to Kami. "You've got it," I said. "Can you start tomorrow?"

On Friday Tegan showed up for work at 8 A.M. sharp. She still wore jeans and a leather jacket, but she changed the jacket for a smock without any objection. I studied her hair covertly: there did not appear to be any lizards in it today. That was a relief; some of my patients would have been frightened of a lizard, and others would have tried to eat it.

I had my soon-to-depart kennelman show Tegan around while I saw my morning clients. Within an hour I noticed that she was doing better work than the kennelman. And she was cheerful about it, too. She whistled as she piled dirty towels into the washing machine; she sang as she changed litter boxes and scrubbed dirty dishes. By the time morning appointments were over, the cages sparkled, the garbage cans were empty, the floors were clean and every dog and cat was snuggled on a freshly laundered blanket. I went outside to the barn and noted that the stalls were raked clean and spread with new bedding. The two horses in the barn were nibbling hay, and their water troughs had been scrubbed and filled to the brim with fresh water. I went back into the clinic and discovered Tegan in the front office, helping Kami answer the phones and file charts. Amazing. Under the magenta hair and the tattoos, Tegan was a gold mine. I owed Howard big-time for sending her here. And *that* meant that I was well and truly obligated to go out to his place for a "surprise" tonight.

I did not enjoy the trip to Howard's place. The fifty-mile drive up Caliente Canyon is bad enough, even if you break the speed limit by a considerable amount, but Howard's ranch roads are worse. Potholes lie in wait, big enough to swallow a truck, and hairpin turns teeter precariously on the edges of cliffs. I suppose the roads discourage trespassers, but I've always wondered how Howard puts up with the three-day-a-week commute to teach his college classes.

When I finally got to the house I got out of the truck cautiously, not sure what to expect in the way of a surprise. In spite of Howard's assurances, I was still expecting a new pet. When the house door opened I jumped about three feet, but it was only Howard, with Lynda behind him. They greeted me politely, then looked at each other as if trying to decide who had to break the bad news.

"We really called you out here for a *good* surprise," Lynda said ruefully.

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"Nothing to do with work at all. But while you're here, do you suppose you could take a look at Curious? I think he has a stoma chache."

I groaned and felt a sharp twinge of pain in my own belly; Curious and his nine siblings were enough to give any veterinarian a bleeding ulcer. I probably had six or seven ulcers by now. Resigned, I got back in my truck with Howard and Lynda, and we drove into the hills until we reached a secluded, deep pool. It looked like a big stock pond from the surface, but if you dove in you'd find yourself in a vast network of underwater caverns, extending for miles in every direction, and so deep that you'd never be able to find the bottom. I stopped the truck and we walked to the edge of the pool. Lynda knelt and slapped the surface of the water, in a distinctive pattern. The water rippled away from her hand, scattering the reflection of the moon. Lynda sat back and waited, and gradually the water stilled. It was silent for a long moment, except for the chirping of crickets and the whisper of wind in the grass. Then the water roiled and splashed, and a sea monster poked its face out of the water. An instant later it was joined by another, then another, until finally ten monsters were swimming happily at the surface.

Actually only nine of them were swimming happily. Curious had been the last to surface (he's usually the first) and he looked preoccupied, as if with something internal. The expression on a sea monster's wrinkled, whiskery face isn't particularly easy to read, but I knew Curious well, and I could tell at a glance that something wasn't right. Curious wasn't even paying much attention to his visitors. Definitely not normal.

I groaned inwardly; I'd really been hoping that Howard and Lynda were imagining things. Howard's sea monsters are unique creatures; they are bizarre spheroidal marsupials with gills, blowholes, four-pronged tails, and whiskery faces. They're still babies, each about the size of a grown man. I don't know how long it takes for them to mature; their parents were at least five times the size they are now. Howard bottle-raised all ten babies when the adults died of an insidious disease. There's nothing else like them in the world, and Howard keeps their existence a closely guarded secret. Which means I'm the unlucky vet who gets to figure out how to take care of them when anything goes wrong.

Lynda persuaded Curious to come out of the water so I could do an examination. He lay placidly on the bank during the process; he was used to examinations. I'd examined all the monsters regularly ever since they were born, taking blood samples and making records of normal monster physiology.

I started at the whiskery nose and worked my way down. The eyes were clear, the gums pink, the blowhole clear, the gills normal-looking. The abdomen was tight and tender to the touch; Curious lifted his head in distress when I palpated it. That was really all I could tell; the monsters' external fat layer was too thick for me to actually feel anything inside. I worked

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my way down to the tail without finding anything else significant, and drew a blood sample from a tail vein. Then I got out my portable x-ray unit and snapped a picture of the belly. Curious slipped back into the water, but he didn't rejoin the others; he stayed near us, resting his head on the bank. Lynda knelt beside him and patted him soothingly. The other monsters clustered nearby, watching, uncharacteristically subdued.

"What do you think?" Howard asked anxiously.

"Well, Lynda's right. It's an acute abdomen. Stomach ache, that is. I can't guess what's causing it, though." I opened the back of my truck and plugged in the little centrifuge; I could at least get a packed cell volume. While the blood was spinning, Curious retched and vomited on the bank. No food, nothing but a little frothy liquid. I frowned; I'd never seen any of the monsters vomit before. I hoped it was a relatively normal physiological reaction for a monster's digestive tract. Curious looked dismayed.

The blood finished spinning and I checked the packed cell volume and total protein. They were both slightly high, indicating dehydration; well, with the vomiting that was no surprise.

Howard hovered over me as I read the blood values. "What does it say?"

"He's a little dehydrated. Only slightly, though, and it's probably from the vomiting. I'll have to take the blood to the lab to find out anything else."

"So what do we do?"

"We treat the symptoms and see what happens." Which basically meant *I have no idea*, but I hoped it would satisfy Howard.

Trying to look confident, I mixed a big batch of kaopectate, activated charcoal, and barium. Lynda took it from me and offered it to Curious, who tasted it and then wrinkled his nose, looking disgusted. Lynda gently grasped a handful of his tentacles and closed her eyes, concentrating, no doubt trying to get across an impression of how important it was for him to take the medication. The sea monsters have an extraordinary chemical sensitivity to touch; they pick up amazingly well on human emotional output. Lynda offered the medication again, and this time Curious reluctantly swallowed it. Then he slipped back into the water and floated just offshore, and his brothers and sisters clustered nearby.

"Now what?" Howard asked.

"Now we wait. We see how he responds. I'll take the blood to the lab and develop the x-ray, and see if anything else presents itself."

"Oh dear," Howard said. He took off his glasses, wiped them compulsively on his shirt, and put them back on, then ran his hands through his thinning hair. "Oh, this is awful. For all the problems we've had with them, they've never really been *sick* before."

Lynda went to his side and put her arm around him.

"Oh, Lynda," he said. "I'm sorry about tonight."

"Don't be silly. We can celebrate another time. Tonight we've got to see to Curious."

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"Celebrate?" I said.

Howard nodded sadly. "Yes. That was supposed to be the surprise. You see, we're engaged." For the first time I noticed the ring on Lynda's finger, the sparkle of a diamond. I've never been too observant when it comes to human beings; I would probably never have noticed without a hint.

"Engaged! Well, that's wonderful! Congratulations."

Ye gods, they were going to be married. That meant that Lynda would *never* come back to work for me, and I'd be stuck with Kami forever. What a hideous thought. I forced a smile and congratulated them again.

But they weren't any more in the mood for congratulations than I was; they were far too worried about Curious. We drove back to the house, and I let them off.

"I'll get going on the labwork," I said. "Keep in touch and let me know how he's doing."

They didn't even go into the house; they went straight for their own truck and headed back to the pond. I crossed my fingers, hoping for the best, and started the long drive back to town.

It was almost midnight by the time I'd dropped the blood off at the lab and returned to the clinic. I developed the x-ray; as I'd expected, I wasn't able to tell a thing from it. My little portable unit just wasn't powerful enough to penetrate Curious' spherical abdomen. Still, with luck I'd be able to see the barium in the digestive tract on the next x-ray, and at least tell if it was moving.

I contemplated going to bed and waiting for the lab results, but I wanted more x-rays and I figured I was too uneasy to sleep anyway. I swallowed some No-Doz, grabbed an armful of x-ray cassettes and a pile of exotics textbooks, and drove all the way back to the sea monsters' pool.

I took x-rays and blood at hourly intervals, stacking up the x-ray cassettes to be processed later. I spun the blood each hour. Curious was slowly, steadily becoming more dehydrated, more pained, more lethargic. The other monsters hovered nearby, looking frightened and rather ill themselves.

"Oh my God," Howard said frantically. "They're all getting sick."

But Lynda shook her head. "I don't think so," she said. "I think they're just reacting to Curious' condition—like they did when Stranger was sick."

Stranger was, true to the name Howard had given her, a stranger thing than even the monsters. She was an enormous serpentlike creature who lived in a deep luminescent cavern and who had never been seen near the surface. The monsters had made friends with her, and apparently they visited her often. She'd been very ill a few months back, and the monsters had picked up on it, showing vague signs of illness themselves although they were perfectly healthy. I hoped that Lynda was right.

At 5 A.M. I sent Lynda back to town to develop the x-rays and pick up the blood-panel results. When she was gone I sat down on the bank, exhausted. Curious lay in the shallows nearby, his breathing labored, his eyes glazed. He was trembling. I remembered that

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his mother had trembled just before she died. Howard paced back and forth on the bank, his footsteps crunching in the gravel, back and forth, back and forth. A cold wind blew out of the hills, ruffling the surface of the pond, and I shivered, stuffing my hands in my jacket pockets.

I dozed off for a time, waking up every few minutes to focus my tired eyes on Curious and make sure he was still breathing. The water sloshed hypnotically against the bank as the monsters moved in the pool, and I fell momentarily into a deeper sleep, still sitting up. I didn't wake up this time until Howard touched my arm.

"Doc," he whispered.

I blinked up at him. "What? Is Curious—"

"Curious is about the same," Howard said in a peculiar voice. "There's something else."

"What?" I rubbed my eyes and squinted at Curious; he still lay in the shallows where he'd been all night. But Howard wasn't looking at Curious. I followed Howard's gaze to the center of the pond.

Enormous limpid eyes stared back at me from a massive snakelike head, suspended five feet out of the water on a slender undulating neck. A mass of fins and streamers fell from the creature's head and neck and trailed into the water. It was Stranger, the stranger thing from the depths. If I hadn't known it was her I would have fainted on the spot. I almost fainted anyway.

"She's at the surface," I said, gabbling. "I didn't think she could come to the surface. What is she doing at the surface?" I'd been convinced that she could only survive at depth; obviously I'd been wrong.

Stranger moved her head toward me; reflexively I moved back. Then she swung her head about, her movements startlingly fast, and touched Curious's face with her snout. Then she disappeared. Hardly a ripple marked the spot where she'd vanished.

"She looked at you, and then touched Curious," Howard said, gazing at me. "She knows you helped her when she was sick."

"So she wants to make sure I help Curious?"

"Yes, but I think . . ." Caddy, one of Curious's sisters, swam suddenly to Howard's side, waving the tentacles of her dorsal fin; he clasped the tentacles absent-mindedly, and then said, "I think we're supposed to follow Stranger."

"*Follow* her?"

"Uh, yes." Howard let go of Caddy's fin and looked at me apologetically. He knew how much I disliked diving.

"But why?" I protested. "What good will that do for Curious?"

"I don't know," Howard said, but he got up and headed purposefully for the little shed where he stored his diving equipment.

"I shouldn't leave Curious alone," I said, following Howard reluctantly.

"Lynda will be back soon."

"Lynda will be worried if we're not here when she gets back."

"We'll leave her a note." Howard began handing out diving gear, and I gave up. Although Howard has a placid nature, once he's made up his mind about something there's no

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stopping him. In short order we were in the dark, cold water, heading down.

Howard swam ahead of me, deep into the pool, and I followed, letting him lead the way. I'd only been down here a couple of times, but Howard dove here regularly, playing with the monsters; he knew his way around. All the tunnels in the watery labyrinth looked the same to me, but Howard headed straight toward one of them and swam into it, and I swam after him. We maneuvered through the maze of tunnels, twisting and turning, until I was completely lost. But Howard knew where he was going, and finally we reached Stranger's vast home cavern.

She was waiting for us, floating in the weird blue bioluminescence that lit her home. When she saw us approaching, she spun about in a great arc and began to swim deeper into the cavern. Howard followed her, and I followed him. We were very deep now, past the three-martini level, and I was feeling fairly giddy by the time Stranger came to a sudden stop, swinging her head around to gaze at us. I simply stared at her, admiring her enormous blue eyes that so closely matched the luminescence around us, until she moved her head toward the wall behind her in what seemed to be a look-at-this gesture.

Clinging to the wall was a cluster of bright yellow plants with fluorescent-orange tendrils that waved in the current. They were terribly pretty. I reached out to touch one, and Stranger smacked my hand with her snout, nearly sending me into a cartwheel. I stared at her in confusion, then belatedly remembered that brilliant colors in marine life often indicate a toxic nature. Undoubtedly the pretty little plants were poisonous. Why was Stranger pointing them out to us? It took another minute for my nitrogen-fogged brain to realize that she was telling us that Curious had *eaten* one. Yet why would Curious eat one? The sea monsters ate fish and other swimming things; they didn't graze on plants that grew on the walls.

I was puzzling through this when Howard caught my arm and pointed. One of the yellow-and-orange plants had launched itself from the wall and was swimming, propelling itself rather like an amoeba. An odd thing for a plant to do. Perhaps it wasn't a plant? Stranger waved her streamers at it and the yellow thing selected a new spot on the wall and attached itself. I gazed at it in fascination until I noticed Howard tugging at my arm. It was time to start back up.

When we finally reached the surface, the sun was up, and Lynda and Tegan were waiting for us. I blinked at Tegan in surprise as I pulled off my mask, noting that her hair was almost as bright as the plant-creatures below.

"I thought we might need more help," Lynda said, "so I brought Tegan. Kami's going to cancel your appointments and take care of the animals in the clinic."

Tegan looked rather glassy-eyed, which wasn't surprising since she'd just met the monsters, but she was already tentatively reaching out to touch Caddy's fin. Caddy swam closer

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and blew a spume of water from her blowhole; Tegan smiled in delight. All in all, she seemed to be handling her introduction to the monsters rather well. I supposed that I shouldn't be surprised; after all, the woman kept lizards in her hair.

"What did the x-rays show?" I asked Lynda.

"It's hard to see much, but the barium stopped about halfway along. It didn't move at all on the last three films."

"Let me see." I hurried back out to the bank, and Lynda handed me the films. She was right; the barium had definitely come to a stop, but it was damned difficult to tell where. Details simply didn't show up on the films.

"What did you find out down there?" Lynda asked.

"I think Curious ate something. A plant or an animal, I'm not sure which. Something like an anemone." I glanced at Howard; he nodded confirmation.

"Something poisonous?" Tegan asked.

"Yes. Poisonous."

Lynda handed me the blood results and I scanned them quickly. Almost everything was out of the monsters' normal range: the liver and kidney values had skyrocketed, and the electrolytes were way out of balance. The values looked remarkably like those of a snakebitten dog. Everything was fitting together in a rather horrible fashion, leading to one inescapable conclusion.

"I brought a full surgical kit," Lynda commented.

I was going to have to do surgery on a sea monster.

* * *

"Surgery?" Howard said frantically. "*Surgery?*"

I knelt in the shallows with Lynda, putting an IV catheter into Curious's tail fluke vein. "Surgery," I said. "It's the only way. We've got to take that thing out."

The IV was in place; Lynda hefted the three-liter bag and hung it from an IV pole that she'd rammed into the mud. I was nervous about giving Curious fluids; aquatic creatures have a very delicate fluid and electrolyte balance. But Curious' balance was so far off already, the fluids would more likely be beneficial than harmful. And what about temperature regulation? Would keeping him mostly in the water be sufficient?

"But," Howard said, "but what if we misunderstood Stranger? What if it's something else altogether?"

"Either way, I've got to go in and look. He's losing ground too fast; we can't be conservative any more."

"But *surgery!*" Howard cried.

"And I need you to calm down. I need you to keep Curious calm, not scare him to death."

"Keep him calm? But aren't you going to use an anesthetic?"

Everything I'd read about cetacean general anesthesia suggested that it was all too often catastrophic, and sea-monster anesthesia was undoubtedly even more dangerous. "Of course I'll use anesthetic," I told Howard, trying to sound soothing. "A local block."

"A local? That's *all?*"

"Anything more would probably kill him, Howard. A local will do the

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trick as long as he stays still and quiet. You know how sensitive he is to us—all you've got to do is hold him and stay calm yourself."

"I—I don't think I can do calm right now," Howard stuttered. "Lynda, could you?"

Lynda glanced at me; I shook my head. "I'll need Lynda to assist in surgery," I said. "Come on, Howard. Take a deep breath."

Howard took a deep breath, but it didn't help; he still looked positively frantic. If he touched Curious while in this emotional state, Curious would be terrified, and that was exactly what I didn't need. Perhaps if I gave *Howard* a tranquilizer . . .

Tegan spoke up then. "I can do it," she said calmly. She slipped into the water alongside Curious and reached for a tentacled fin. Gently she took the fin into her hand, settled herself comfortably in the muddy shallows, and closed her eyes. At her touch, Curious visibly relaxed. I blinked in amazement and relegated Howard to fetching and carrying.

We coaxed Curious into rolling on his side, and got him positioned. I injected the local under his skin with some trepidation, hoping it wouldn't be toxic to him. When I had finished the block, Lynda prepped the site, and I set up for surgery as well as I could, considering that we were going to have to operate in the water. I laid the packs out on the bank, donned my mask and gloves, and waded out to my patient with scalpel in hand.

I took a deep breath, hoping it would work better for me than it had for Howard. Curious lay quietly before me, his eyes closed, his tentacles wrapped around Tegan's fingers. Tegan sat in the shallows like some fantastic spike-haired water nymph, a trancelike expression on her face. Howard paced nervously on the bank, and out in the pool the other sea monsters floated with barely a ripple, watching. I made the first incision.

There was no reaction from the patient; the local appeared to be working. I cut deeper, making my way through the heavy layer of subcutaneous fat and into the muscle. Still not a twitch from Curious, and he was still breathing regularly. I opened the abdominal cavity and peered inside.

There was nothing remarkable at first sight. Loops of intestine, mesenteric fat and blood vessels, omentum. I worked my way up to what appeared to be a set of stomachs and began to follow the intestine down, examining it systematically. It didn't take long to find the problem: a section of intestine that was blackish-red, swollen and lumpy.

"What did you find?" Howard called frantically. "What are you doing?"

"There's an inflamed piece of intestine here," I called back. "I'm going to see what's inside." Under my breath I whispered to Lynda, "How's Curious doing?"

She shrugged helplessly. "He's alive. He has a pulse and he's breathing. That's about all I can tell you."

"That's about all I can ask for. Here we go."

I made an incision in the intestine, and a bright orange tendril popped out. Lynda jumped, startled, and near-

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ly fell backwards in the water. Carefully I enlarged the incision until we could see most of the creature's body.

"Is it alive?" Lynda whispered.

I looked at it doubtfully. How could it possibly be alive after all that time in the digestive tract? The tendril had probably popped out because of a release of pressure. It hadn't moved by itself. Had it?

"Is it?"

"I don't think so. Careful, don't touch it. We'd better only handle it with instruments."

"OK."

I poked a large forceps at the creature and clamped down on a piece of it. Gingerly I began to tug at it. Nothing happened; it was stuck tight to the intestinal wall. I pulled harder, then used another instrument to try to pry it free of the intestine.

"What's happening?" Howard called plaintively.

"It's one of those yellow and orange things. We're trying to get it out."

I shifted the instrument to a different position and rocked it back and forth. Something gave way, like a suction cup releasing, and then suddenly there was a violent thrashing of tendrils and the creature leaped out of the intestine and twisted frantically on the end of my forceps. As I gaped at it the thing tore itself loose and flopped across Curious' body straight toward Tegan.

"Tegan!" Lynda screamed.

"Tegan, look out!" I yelled.

Tegan snapped out of her trance, saw the thing coming, and dove out of the way. A blur of yellow and orange flashed past her and disappeared into the water. I gasped with relief. And then my surgical field lurched up against me and hit me in the face. Curious, terrified, was thrashing in the water, with his abdomen open and a hole in his intestine. I grabbed the piece of intestine, clamping my fingers down on either side of the hole, and held on for dear life. Lynda snatched some of the instruments, but the rest tumbled off the surgical field and splashed into the water. And then, mercifully, the thrashing stopped. Tegan was back in her place, dripping wet, soothing Curious with gentle fingers. Shakily, I continued with the surgery.

The intestine was too badly damaged for mere suturing; I had to resect the damaged piece and then anastomose the ends, a tedious piece of surgery even when half of your instruments haven't disappeared underwater. But I finished at last, and closed, and when I was done Curious was still alive.

And he was, remarkably, already looking better. He rolled up onto his chest, peering back curiously at his incision. The other monsters swam up to him, squeaking and clicking, touching him gently with noses and fins. Then the other nine swam off together, to the center of the pool, and began to play.

Lynda smiled tiredly. "Well, *they* seem to think he'll be all right."

I stripped off my mask and gloves, gathered what instruments I could find, and staggered up the bank to collapse beside Howard. Lynda followed with the piece of resected intestine bundled in a drape. It was

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probably best that Howard didn't look at the thing; he was pale enough already, and he was still shaky.

"Is it over?" he whispered.

"It's over," I said. "He made it through surgery and he's already looking better. So far so good." Removing the poisonous creature and the damaged intestine had done wonders; now all we had to worry about were mundane things like infection, dehiscence, and whether the antibiotics I was going to have to use were safe for sea monsters. I got back to my feet and staggered to my truck to contemplate the selection of antibiotics. Lynda put an arm around Howard and gently took him out to visit with Curious, and Tegan discreetly moved away. I watched Tegan distractedly as she began to dive like a mermaid for instruments. She surfaced with a thumb forceps, then went back under and returned with a Doyen clamp. I sighed. I really could have used that Doyen during the surgery. And I'd have to do an inventory before I left, to make sure I had all the instruments; otherwise one of the monsters might swallow one, and I'd end up doing surgery again. I shuddered at the mere thought of that, and picked up an aquatic-medicine text, hoping to find a dolphin or sea lion antibiotic dose that I could extrapolate for Curious. I was immersed in tables of doses when Tegan came up to me with an armful of instruments.

"Here you go," she said. "Say, could I use some of your exam gloves?"

"Sure." Absently I handed her the box and got out my calculator to figure a dose. Then, not trusting my tired and foggy brain, I double checked the calculations.

"Oh wow," I heard Lynda say. "Look at that."

"Oh dear," Howard said. "It's hurt."

I looked up from my calculations. Tegan stood in front of me, the orange and yellow anemone-thing cradled in her gloved hands.

"Aaaah!" I cried.

Tegan looked at me reproachfully.

"That thing's dangerous," I sputtered.

"It should be safe to handle it with gloves on, shouldn't it? Look, one of the tendrils is torn partway off. Can you fix it?"

I peered doubtfully at the creature in Tegan's hands. Apparently she was right about the gloves, since she was still standing and she showed no signs of being poisoned. But what in hell could *I* do for the thing? Surely any creature that could survive for several hours in a monster's digestive tract could take care of itself. Reluctantly I put on gloves and examined the injured tendril more closely. It was torn nearly all the way off, hanging only by a shred of tissue. Guiltily I recognized the mark of my forceps. I did feel obligated to do something. But what? There was probably too much damage to reattach the tendril; undoubtedly the best thing would be to amputate it. After all, the thing had plenty of other appendages. And maybe it could regenerate its limbs, like a starfish. But would suturing the wound interfere with a possible regeneration?

"Can you?" Tegan asked again.

I looked at her earnest, hopeful

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face and said in my most confident tones. "Of course."

Two weeks later, Kami spiked her hair and attempted to dye it magenta, but it came out yellow and orange. I nearly screamed when I saw her come in the door.

"Hey, your hair looks cool, Kami," Tegan said cheerfully. "Don't you think so, Michael?"

"Uh, yes. Cool. Very."

Kami smiled and went into the front office. I looked for tattoos as she passed by, but none were visible so far. I sighed. Kami had been studiously copying Tegan's appearance for the past two weeks, but so far there was no sign that she was picking up any of Tegan's work ability.

The morning passed fairly uneventfully. I treated a dachshund with a head injury (it had been chasing a cat across the street, and had run into the curb), vaccinated some kittens, and rechecked Howard's thirty-seven baby tortoises. They were all doing fine.

"And Curious is doing great," Howard said. "Lynda took out the stitches yesterday. I think he's proud of his scar."

"I just hope he doesn't try to collect any *more* scars. What did you do with the yellow and orange thing?"

"First we showed it to all the monsters, and made sure they knew it was what made Curious sick," Howard said. "Then we took it back where it came from."

I was wondering if the thing was still alive (I'd been having a lot of nightmares about anemone-things leaping out of my surgery sites and plastering themselves to my face) when Tegan knocked on the exam room door and hurried in with a large golden retriever. The dog's owner followed, surrounded by a cluster of small children.

"Sorry to interrupt, Michael," Tegan said, "but I think this dog's choking."

"Let's have a look."

The dog's eyes were glazed and frightened, and she was struggling for breath. I pried open her mouth and stuck my hand down her throat. Sure enough, something was in there. But what? Not a bone, not a ball . . . it had rubbery *spikes* of some kind. Oh well, at least there was something to grab on to. I got hold of the thing and began to work it loose. It came free with a sudden lurch and I saw it fly across the room. Ye gods, a yellow and orange thing! And I had touched it with my bare hand! It bounced off the wall and came back toward me, and I yelled and lunged away from it. Slowly the thing rolled to a stop, and I stared at it. Everybody else stared at me.

"Oh look," I said feebly. "It's a dog toy."

After I had discharged the golden retriever (with firm instructions about what size toys it might play with), Howard asked if I could come over to his place that evening.

"Lynda and I are going to have another try for a celebration," he said. "And you could see Curious."

"Sure," I said. "That'd be great." It *would* be great, except, of course, for the hideous fifty-mile drive.

"I've asked Tegan to come too.

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Maybe you two could ride together."

"Tegan?" I brightened, imagining the fifty-mile drive with Tegan for company. Suddenly the prospect seemed much more pleasant.

"You like her, don't you?"

"Well, sure."

Howard smiled, looking rather smug. "Thought so." He picked up his box of tortoises and headed out the door.

"See you tonight," I called after him, and sat down in the empty exam room to do some thinking. What would be the best way to ask Tegan to come with me? I really shouldn't come across like I was asking her for a date, after all. I'd always figured it was best not to get involved with employees. Especially not with employees who had tattoos and kept reptiles for pets. She might even have snakes, for all I knew. Perhaps I could refer to the trip to Howard's place as a car pool.

On the other hand, I found myself remembering how Tegan had looked sitting in the water with Curious, her eyes closed, her face beautifully serene. I remembered how gracefully she swam and dove, like a mermaid.

What was I thinking of? I couldn't possibly be *attracted* to someone as strange as Tegan, could I?

Of course not. I would just go and casually invite her to car pool to Howard's place.

Suddenly there was a knock on the door, and Tegan stuck her head in. "Hey Michael," she said, "would you like to come with me to Howard's place tonight? I'll drive."

I stared at her, my carefully rehearsed speech fizzling in my mind. "Uh," I said. "Um, yes. Sure."

"Great." She smiled and closed the door.

Well. So what if she was an employee. So what if she had tattoos and reptiles. I really shouldn't let little things like that stand in the way of dating possibilities.

It was going to be a wonderful evening. ■

(Editor's note: Other stories of Dr. Clayton and Howard's pets include "Little Monsters" (11/89), "Business as Usual" (7/91), and "Stranger Things" (6/92).

In the intercourse of polished society a young person will more frequently need an acquaintance with the creations of fancy than with the discoveries of science or the speculations of philosophy.

— Thomas Bullfinch

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G. Harry Stine 1928-1997

G. Harry Stine, well known to *Analog* readers for his fiction, science fact articles and "Alternate View" columns, died November 2, 1997, of his second heart attack in two years. At 69, he had seemed to be fine as recently as the morning of his death, and he died "with his boots on"—at his computer keyboard, at his home in Phoenix, writing.

Born in Philadelphia and raised in Colorado and New Mexico, Harry earned a degree in physics and worked for several companies as a rocket engineer. He was prominent in the development of model rocketry, and wrote extensively—and sometimes testified before Congress—about the real exploration of space. For much of his life he was a private pilot.

His first fiction sale was to *Astounding*, as this magazine was called in 1951. "The Galactic Gadgeteers" ran under his own name, but most of his subsequent fiction, including some two dozen novels, was bylined "Lee Correy," to keep it distinct from his engineering work. "Shuttle Down," serialized here in 1980 and 1981, brought the two sides of G. Harry Stine together by leading to NASA's revising its procedures for recovering a downed space shuttle. His nonfiction included not only a great many articles, in *Analog* and many other places, but another couple of dozen books.

Perhaps his most distinctive contribution to *Analog* was as one of the two founding columnists of "The Alternate View," and the only one to do the column all the way from its inception in 1979 until shortly before his death in 1997. The name of the column was originally conceived as having two meanings: it was to be a column of science and technology news reporting and opinion, alternating between two regular columnists, and often attempting to provoke thought by expressing viewpoints different from those in vogue. Harry wrote the very first column, never missed a deadline, and never failed to stir up a controversy.

He is survived by his wife, Barbara, three children, two grandchildren, a great many model and full-scale rocketeers, and a widespread following of readers—including the many who looked forward every other month to seeing what he would say in his bimonthly column to delight, annoy, or inspire them. All of us will surely miss him. ■

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THE ALTERNATE VIEW Jeffery D. Kooistra

THE PERMANENT ALTERNATIVE

I'm a fan of the "Ask Marilyn" column that appears each Sunday in *Parade* magazine in my hometown paper. For those who don't know, Marilyn vos Savant, the Marilyn in "Ask Marilyn," has the highest recorded IQ score in history, and her column consists of questions readers ask trying to stump her, and little puzzles to do for the people who enjoy such things.

One column a number of years ago contained the following puzzle that went something like this (there are many variations): You're a contestant on a game show and the host shows you three doors. He tells you that behind two doors are goats, and behind the third is a prize. You choose a door. The host, knowing where the goats are, then opens one of the other doors and reveals that there is a goat behind it. He then asks you if you'd like to change your choice to the other remaining door or if you'd like to stick with the one you have. The question is this: Do your chances to win improve by switching doors, by sticking with your original choice, or are your chances to win the same either way? (I'll give the answer at the end of the column. Don't cheat!)

Well, I disagreed with Marilyn's answer, thought about the problem for about 15 minutes, convinced myself that the World's Smartest Human had blown it, and right then and there wrote her a letter pointing that out. Later, I described the problem to some friends, explained her answer, explained mine, and essentially convinced them that I was right.

The next day, one of those friends (Randy) called me just before I was supposed to go out on a date (with Dorothy), and told me that he'd been thinking about that problem all day, and that I was wrong and Marilyn was correct after all. I didn't buy it and set off for my date.

The drive to Dorothy's took about 20 minutes. I couldn't keep myself from going over the problem in my head, and before I got to Dorothy's house, I began to have some doubts. The first hour of our date didn't go too well since I couldn't focus on anything except the problem, but I came to see that, oops, I was wrong, and the next day I verified it experimentally.

I didn't give the issue much thought until a few weeks later when "Ask Marilyn" printed letters from readers absolutely livid with her for giving the wrong answer. (My letter had been polite, but it wasn't printed.) She was accused of perpetuating bad logic, and this in an era when math scores are heading south and so many people are

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incapable of logical thinking to begin with. I remember specifically one of these critics who puffed up his chest and pointed out that he said this as a Ph.D. in Mathematics.

Marilyn responded that her critics on this were wrong, and attempted another explanation to try to make her answer more clear. Weeks later, some still didn't agree and were even angrier.

I learned two lessons from that column, and I took both to heart.

What was different about me, that I would reconsider my earlier solution and thus finally arrive at the right answer, from those who, even after several explanations, could not see that their solutions were incorrect? (The answer isn't that hard to understand if you just work through it.)

I think the most important lesson was simply admitting to myself that, despite my original certainty, I could still be wrong. I realized that 1.) Randy is every bit as good as I am at figuring out these sorts of logic problems, and 2.) he'd spent a day thinking about it and I'd called it quits after 15 minutes. Even after convincing myself in my mind that Randy (and Marilyn) were right, the next day, I still made myself little labeled pieces of paper and physically ran through all the possibilities.

This second bit of "doing the experiment" is very important. Earlier, I had, through thinking alone, convinced myself of a solution that was wrong. After reconsidering the problem, I then convinced myself, again through thinking alone, of a different answer. I didn't change my answer because of some sudden infusion of additional brilliance, so it was still possible that I had only managed to convince myself of yet another wrong solution. Only after I plowed through all the possibilities and tallied up the percentages was I convinced that my second answer was the right one.

The second lesson I took to heart was that authorities in various subjects can blow it, too. A Ph.D. in math was certainly no guarantee against getting a wrong idea into his head for one critical writer. More generally, a Ph.D. is no guarantee against stupidity, nor is a high IQ.

Yet sometimes we're forced to act as if they are.

Anyone could have taken the time with the logic puzzle to physically work through all the possibilities, but when it comes to bigger problems, we usually must concede to authority, with the built-in assumption that said authority holds views that are right. But how do you verify that that particular assumption is valid?

In general, you can't—you just have to see what kind of verdict history renders. And this is as true in science as it is anywhere else.

Gene Mallove had an excellent fact article in the July '97 *Analog* about what really happened with cold fusion. The initial claims of Pons and Fleischmann were hard to believe, and flew in the face of what we thought we knew about nuclear physics. Nevertheless, the verdict has been rendered and the SRI report of late 1996 verified that Pons and Fleischmann did, in fact, produce excess heat (whether or not it was "fusion" is another mat-

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ter!). But the bulk of the physics community still doesn't know this, and still thinks cold fusion is the quintessential example of pathological science.

In my view, what was most pathological about the whole cold fusion deal was that so many physicists just accepted that, after one summer of usually failed experiments done by a few admittedly prestigious labs, this was enough to cinch the deal and write the whole thing off. (That other less ballyhooed but not less competent labs achieved positive results was largely ignored.)

Cripes. Anyone who has done experimental physics should know that it can take years to get an experiment to work right. They would have learned this from bitter experience. That most laboratories couldn't duplicate P & F after a few months of trying should have been expected, and yet rancor, name-calling, and a few failed experiments were allowed to carry the day. We could have saved a lot of time if our "authorities" would have admitted the possibility that they could be wrong.

What brought the lessons of the "Ask Marilyn" column to mind recently was another *Analog* fact article, Richard Meisner's thought provoking "Cosmological Darwinism" (November, 1997). The article dealt with the "fine-tuning" of certain fundamental constants of nature, necessary for life to arise, and whether or not there is some "Darwinian" way to account for this without invoking conscious design (although you do invoke an awful lot of additional universes that weren't fit enough to make it).

Analog readers who don't skip the fact articles are certainly familiar with the Big Bang scenario of the origin of the Universe. In the beginning, all of the matter in the Universe exploded out of one tiny point. The 3 Kelvin background radiation is supposed to be the radiation echo of this event. Now, this background is very uniform (isotropic)—which to astrophysicists suggests that in the earliest fraction of a second of history, the Universe underwent a period of inflation—a faster-than-light expansion. This accounts for the uniformity, but also allows for just enough ripples in the background (anisotropy) to account for galaxy formation.

But here's the deal—the duration of this inflation had to be fine-tuned at the beginning to on part in 10^{60}. Too short a period, and you get recollapse—too long, and the Universe spreads out to nothing.

I don't wish to take issue with the whole article (one of my favorites of last year, by the way), but only with one statement therein. Meisner says there are not two, but three possible distinct paradigms to account for cosmological fine tuning: 1.) Design; 2.) the assumption that all universes that can exist, do exist; and 3.) this Cosmological Darwinism idea, where universes "compete" and only ones fit for life to develop survive. I submit that there is always one other alternative—any one or all of our fundamental assumptions about the nature of the Universe might be wrong.

To me, the necessity of a one-part-in-10^{60} fine-tuning of inflation at the moment of creation for the theory to work is a big hint that the whole damn thing is wrong.

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There are alternate explanations to account for both the existence and the isotropy (and trivial anisotropy) of the cosmological background radiation. There are alternate explanations for cosmological redshift (another supposed Big Bang relic) besides universal expansion. One-in-10^{60}? My God, the parting of the Red Sea is more likely than that on any given day! Alternative explanations to the currently accepted ones for various observational facts about the Cosmos seem far more likely to make the need for extreme fine-tuning go away than the invocation of some huge number of competing alternate universes.

Granted, you can't do science without assuming that much of what you "know is true" really is, but it doesn't cost anything to bear in mind that you, personally, and we, collectively, don't know it all yet and never will. The Geocentrists couldn't bring themselves to dump their brilliant epicyclic solutions, and even Copernicus kept epicycles in his sun-centered approach. Say what you will about the progress of science, but Human nature hasn't changed since we've been keeping tabs on it. That scientists and people in general hold on to ideas long after they should have been discarded is a fact far better established than any view of how the Universe came to exist is likely to be.

Now, back to that puzzle. I don't want to get a bunch of letters griping that I gave the wrong answer, so here goes the brief explanation.

Your chances of winning are much better if you change your guess. Recall that the game show host knows which doors the goats are behind. At the outset, you pick one door and thus have a 1/3 chance of being right, and there's a 2/3 chance that the prize is behind the other two doors. When you pick your door, and he opens one of the others, there is a zero percent chance that he'll open a door with the prize behind it. Therefore, that whole 2/3 chance of winning is behind the door you didn't pick. Where I went wrong initially was in "resetting to the new situation"—seeing two doors and knowing behind one was a goat and behind the other was a prize, and assuming the chances were now 50/50.

That assumption was wrong. ■

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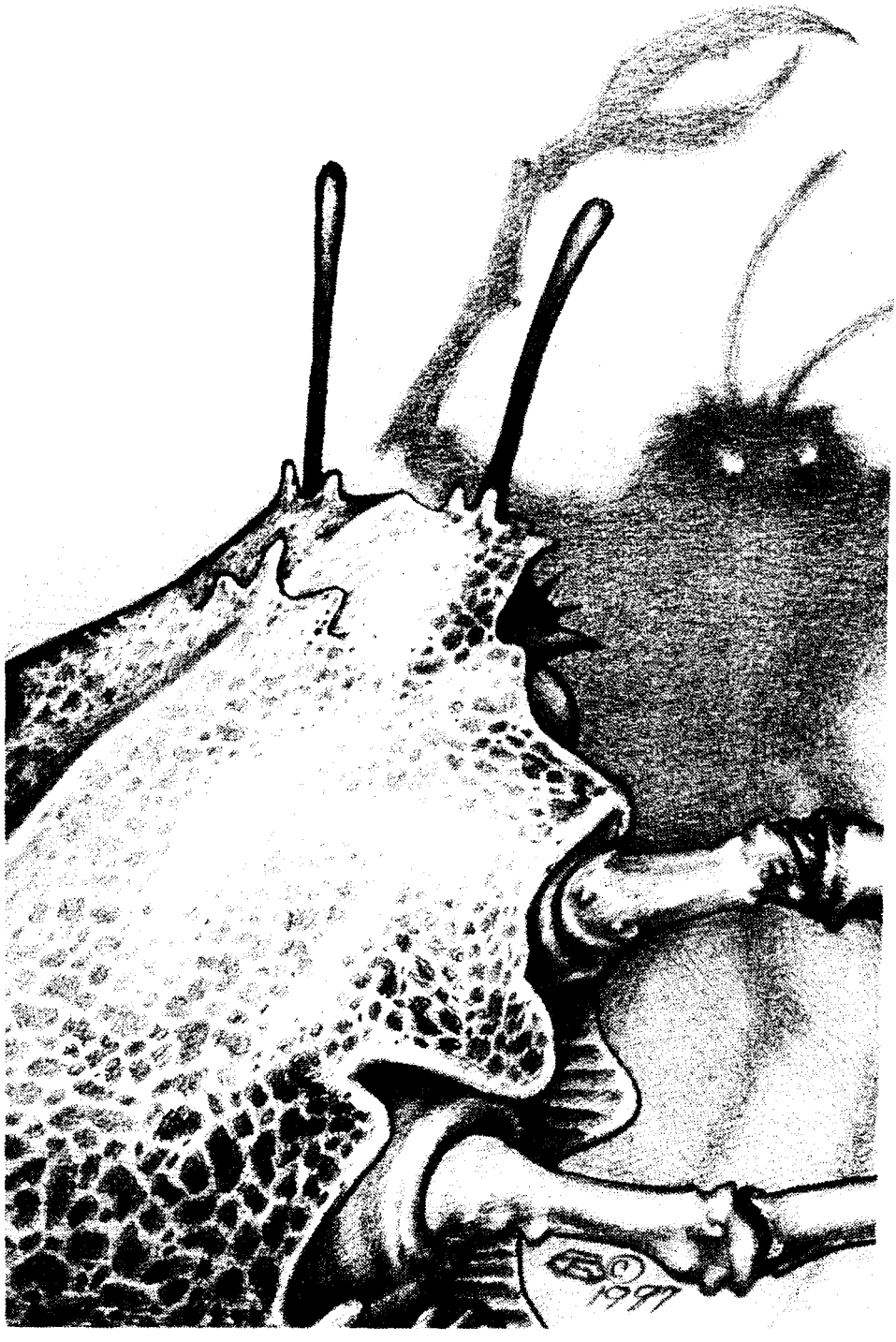

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Stephen Goldin

The Sword Unswayed

Solving a crime depends on understanding motives—and that depends on culture. . .

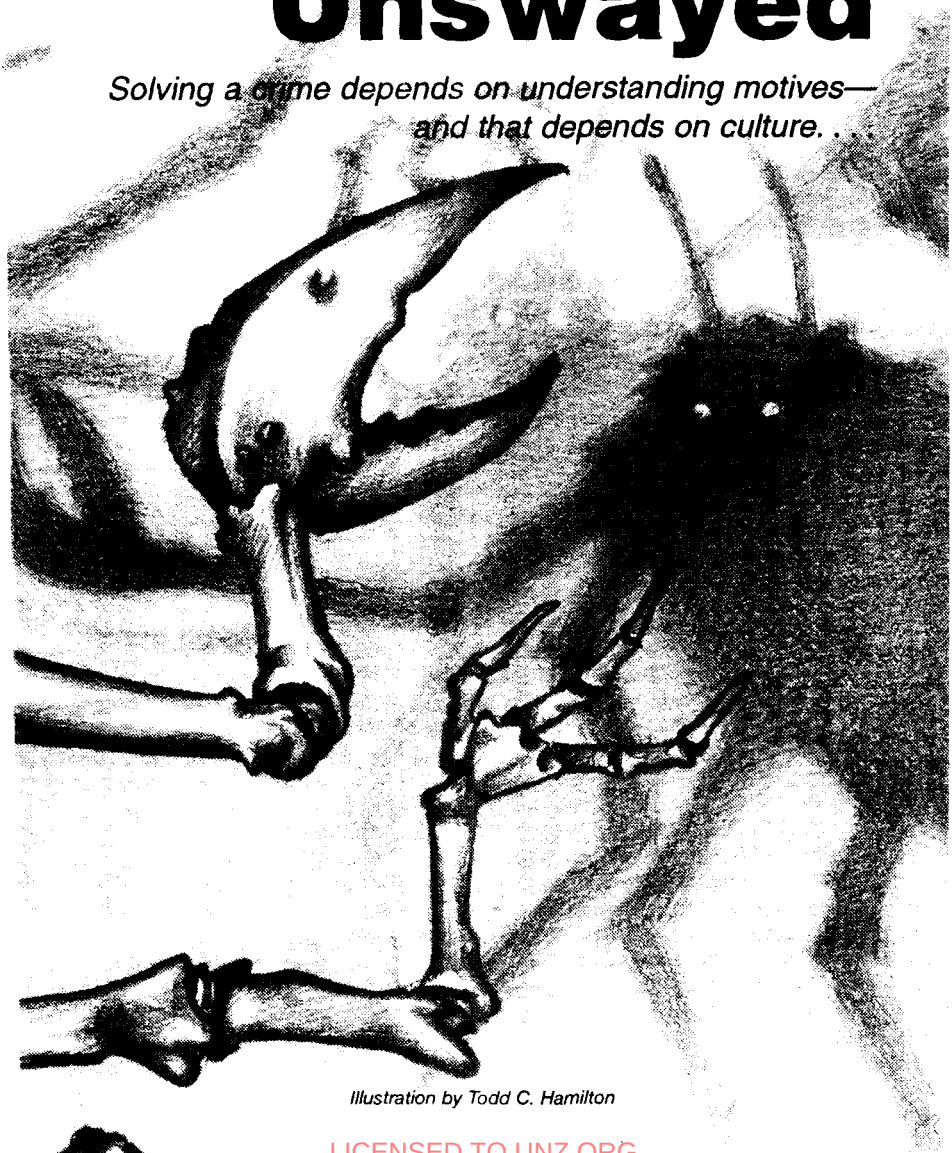

Illustration by Todd C. Hamilton

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The attack by the mad alien robot surprised everyone at the cookbook writers' award banquet.

The official banquet had just broken up; the speeches had all been delivered; the awards had all been presented. People milled about in small groups as the crowd slowly filtered out of the dining hall. Bian Dinh stood beside her chair, her petite figure outlined by the gold silk dress embroidered with red dragons. "Did you hope to make the party rounds tonight, Debs?"

Rabinowitz winced at the college nickname. She'd already told Dinh three times she preferred "De-BOR-ah" these days, but the other woman steadfastly refused to listen. "Actually, I hoped to avoid them. I like writers individually, but in groups . . ." She gave a mock shudder. "As soon as they learn I'm a broker, they swarm on me to sell their books offworld. I hate saying no."

"So I remember."

"Well, I've learned *how* to say it, now, but I get tired of the way they look when I tell them it's easier to snag the lottery."

"I wasn't looking forward, either, to the parties. These people are all *dreskas*, they talk of nothing but business. Recipes and book contracts, as though the people who ate the food were less important than the ingredients that go in it. The oppressed people of the world can't even afford most of the spices they write about." She paused. "I hoped we could have a more private reunion. We haven't seen each other in seven years—"

"I'll have to ditch that too, I'm afraid," Rabinowitz said. Then, as she saw Dinh's expression fall, she added, "I have to be sharp for a rehearsal tomorrow."

"Rehearsal?"

"Yes, I direct an amateur theater group these days. We open the Scottish play in two weeks, and tomorrow's our first full run-through."

There was a sudden commotion in the back of the hall. People were pushing and jostling and there were a couple of surprised shouts. Suddenly an alien's rented robot body broke through the crowd and started toward the center of the room.

It was a cheap older model, with a short, thin unisex body and indeterminate facial features. Its clothes were painted on and peeling, while its face was covered with small scratches and dents from users who tried to do unaccustomed things with it.

The current user was also not very adept. The body leaned forward, having a hard time balancing upright, while the arms swung about in front as though the user were unsure whether to use them as legs. The head turned from side to side as though used to scanning its surroundings much more quickly. If it weren't for the path of bruised and fallen people it had pushed aside in its crude rush into the hall, the creature would have been laughable.

"Malfunctioning?" Dinh wondered.

"No, it's turned off the autos," Rabinowitz said. "It couldn't be shoving people if they were on."

The robot had cleared a space for itself through the mob that scattered before it. Its gaze reached Dinh and

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Rabinowitz, and suddenly stopped. With a roar of incoherent syllables, the alien picked up a butter knife from a nearby table, lowered its head and charged straight at them.

Even dressed as they were—Dinh in her tight silk dress, Rabinowitz in her black strapless formal with the half-high heels—either woman could have outrun the alien in a foot race. But the surprise of its attack froze them momentarily; the alien was almost upon them before they reacted. Rabinowitz recovered first. Grabbing the chair next to her, she swung it straight into the attacker's path.

A human could have easily avoided the obstacle and kept on coming. Even an inexperienced alien who left the automatic guidance system turned on would have moved casually around it. But this alien had the autos off and didn't have the proper reflexes to deal with sudden changes. Its legs hit the chair and lost what little balance they had. The creature sprawled on the ground and slid across the polished floor three meters past the women who had been its targets. Rabinowitz and Dinh each tossed on a couple more chairs, then together overturned a round banquet table and pinned the hapless robot beneath it.

The alien tried to get back up, flailing its robot limbs madly and looking like a turtle trying to swim across a tile floor. The tension in the room broke and everyone started laughing. The alien, realizing its position was hopeless, suddenly froze in place.

"Show's over," Rabinowitz announced when she could stop laughing long enough. "He's off-teeped and gone home. Somebody call the police."

The police came, in the person of one detective and one uniformed officer. They impounded the rent-a-bod and asked general questions of everyone in the hall. When they learned the alien had homed in specifically on Dinh and Rabinowitz, they asked more pointed questions of them. Both women acknowledged knowing and having business dealings with extraterrestrials, but neither knew of anyone, off Earth or on, who wanted to kill them. Finally, after two hours of taking statements, the police left.

"Well, that was a nice little adrenaline rush," Rabinowitz said, "but now I really *do* have to be going if I'm to be at all coherent tomorrow."

"I really did want to talk with you," Dinh said, reaching out to grab her arm. "I hoped that we could . . . well, I never get a chance to see you in person, and there's much to tell you."

Rabinowitz looked into Dinh's eyes, sighed, and quickly reviewed her schedule. "Will you still be in the City Monday? Good, why don't we have lunch then? Call me Monday morning and we'll set up a time and place."

As she walked away, Rabinowitz could feel Dinh's eyes following her with a strange intensity. She almost wished she hadn't made the date. Whenever Bian got this intense back in college, trouble usually wasn't far away.

"This could be unpleasant," she muttered. "Please, Bian, I hope you're smart enough to know that some things exist better as memories."

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* * *

The bare stage was littered with burned timbers, all that remained of the once-proud Globe Theater. You could almost see little wisps of smoke curling upward from the charred beams that had fallen diagonally across the stage during the fire. You wondered whether there might still be glowing embers about, and how safe it was to even be in the audience. The perfect ambiance for a play in which no one was safe.

An actor entered stage left and walked to center stage, deep in thought and oblivious to the audience. He wore tights and slippers, but was bare from the waist up. He stood pensively for a moment, until a dresser entered stage right carrying an oddly padded vest. The dresser handed the vest to the actor and exited again stage right. The actor slipped on the vest and fastened it down the front. The padding gave an odd curvature to his back.

The dresser entered again stage right, this time carrying a brown tunic embroidered with gold and a wig with long, straight hair. He set the wig momentarily on a charred beam as he helped the actor into the tunic, then arranged the wig on the actor's head with professional precision. His tasks now complete, the dresser exited, again stage right.

The actor watched him depart. As he did so, a transformation came over him. His left shoulder slouched, his right shoulder raised, and his head tilted slightly to the right. He was now a hunchback.

Alone again on stage, he turned and saw the audience as though for the first time. He smiled then. Not the somber smile of an archvillain contemplating his sinister machinations; no, this was the smile of someone who knows a devilishly funny joke and is about to let you in on it. His tongue was so far in his cheek it practically came out his ear.

"Now is the winter of our discontent," he began, "Made glorious summer by this sun of York."

Rabinowitz found herself in two places at once: sitting spellbound in the audience as this improbable impostor outlined the joke he intended to play on all of England, and standing in the wings mouthing the lines along with him. Yet somehow there was a still, small voice saying clearly inside her mind, "No, you're the wrong murderous schemer! The War of the Roses is centuries away. Where are my witches? Where are my secret, black and midnight hags? Clarence, Brakenbury, guards, you're on!"

Alarms buzzed insistently. The world whirled around her. She sat up as the burned-out theater melded in surreal counterpoint with her bedroom. The lights rose from darkened to dim, letting her see without immediately blinding her. A small yellow light was flashing in the wall to her left.

"Alarm: status," she said.

"Potential intruder, front porch. No penetration, but testing door and windows. Should I call police?"

"First the alien at the banquet, now this," she muttered. Then, more loudly, "Not yet. Turn on porch light. Intercom, sound only: Hello out there. State your business, quickly."

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"Debs, please. I must see you now. There's trouble, and I need your help!"

Bian Dinh! "Be right down. Intercom: off." Rabinowitz rolled out of bed and grabbed a robe from her closet. "I knew this was going to be unpleasant," she muttered. "Why are my instincts always so right?"

Bian Dinh sat in the middle of Rabinowitz's living room couch, sipping hot chocolate laced with brandy. She was still shaking, though the drink was starting to calm her down. Rabinowitz sat beside her, trying to soothe her old friend while she herself was anything but tranquil.

"I tried to call you, I swear it," Dinh said, "but your p-code was on and I couldn't slice through, so I thought I should come by in person and try to wake you, but I was so nervous and it was so dark that I wasn't sure what to do—"

"Slow down," Rabinowitz advised. She reached out to momentarily stroke Dinh's short, black hair. "Breathe a little. Don't say anything more until you can figure out where the periods go in your sentences."

Dinh took some deep breaths and a few more sips of her drink. Finally she said, "Where should I begin?"

"Well, what did you do after I left you at the banquet?"

"I returned to my room and teeped to K'tolu'tan." Dinh snapped her fingers twice as she pronounced the alien word. From her own experience, Rabinowitz guessed that was just an approximation of the real sound.

"Is that a planet? I thought I'd heard of almost everyplace, but I'm not familiar with that one. Why'd you go there?"

"I was meeting a publisher. He wants to commission a book from me."

"Is that why you wanted me to stay with you after the banquet?"

"Well, one reason. But I don't think it will do any good now."

"Why not?"

"Because he's . . . he's dead. I discovered him lying on the floor."

"Natural causes?" Rabinowitz asked hopefully.

"There was a knife through his chest."

"Doesn't sound terribly natural. Have you notified any authorities?"

"I didn't know who to call on K'tolu'tan, and you know what I think of our own police. The only person I could think of was you. You're always so . . . organized."

Rabinowitz paused for a moment. "I have no idea who to contact on . . . K'tolu'tan, was it?—but I think I know a way to get things started. Phone: Voice only. Interpol, San Francisco office, Detective William Hoy."

Dinh's eyes widened. "Interpol? You?"

"Relax. It's not what you think. It's not even what he thinks."

"Detective Hoy is not on duty at this hour," came the voice from the Interpol switchboard. "Will some other detective do, or should I route you to his message area?"

"This is only for Detective Hoy. Route it through his personal code. Tell him Deborah Rabinowitz called on a matter of life and death. Phone: off."

Dinh shook her head. "I don't know whether it's wise to bother an

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Interpol detective on his time off—"

"He owes me entirely too many favors. It's time I started collecting on them, anyway."

Dinh sipped on her drink for a moment, absorbed in some thought she didn't know how to voice. Finally she said, "There may be a scandal involved in this matter, you know."

"On Earth, on K'tolu'tan, or both?"

"K'tolu'tan. Perhaps. I don't know."

The phone chimed. It was Hoy. His broad face on the living room screen bore a look of concern, and his hair was rumpled. "Are you all right? What's the trouble?"

"I'm fine. Thank you for asking."

"Your message said life and death."

"Yes, but not mine. A friend of mine seems to have stumbled across a murder on a world called K'tolu'tan."

"Is this something contagious? Do you give it to your friends?"

"She'll need a sympathetic ear, and she's far more attractive than I am."

"Impossible, but I'll be there within an hour. Phone: off."

"What did he mean by 'contagious'?" Dinh asked.

"Well, believe it or not, I know exactly how you feel. I stumbled across a murder a couple of months ago myself, and Detective Hoy . . . well, 'helped' isn't quite the right word, but he did keep me centered long enough to solve the case. He'll at least know who to contact for you. In the meantime, until he gets here, let's keep our minds on other things."

Dinh sipped some more of her hot chocolate thoughtfully and said nothing.

"I was having a dream when you came onto my porch," Rabinowitz said. "You weren't in it, but I think it was about you, in a way."

"What was it?"

"It was about a production of *Richard III* I directed in my senior year at UCLA. I'd found the notes for it in the drama department files; it was first staged that way over a hundred years ago, but it sounded like fun and I convinced the department to let me try it. It worked well, we got some nice reviews."

"What has that to do with me? I was not in it. I never even saw it."

"No, but that was the time I met you. While I was directing that play I started taking the orientation sessions for Polycultural. You remember those."

Despite her hot drink, Dinh shivered. "Yes. There were times I was sure I would not survive the orientations, let alone the institute itself. If you had not helped me, I don't think I would have."

"We helped each other," Rabinowitz said. "I can remember times—"

She broke off in mid-thought. She had no desire to get into a reminiscing contest with Dinh. She had all too good an idea where that could lead them.

More silence descended. It was Dinh who broke it this time, though she, too, was avoiding the subject of the murder. "I still have trouble believing where our paths have taken us. Who would have thought you would become a reputable, sedate literary broker?"

"Only the people who'd also predict you'd write cookbooks."

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"Please. Treatises on food preparation as sociological phenomena."

"Complete with recipes."

"Complete with recipes." Dinh laughed for the first time since entering the house. "Imagine, us—the two most rad of the radhumfems—making our livings so mundanely."

"But times do change and move continually."

"You and your Shakespeare."

"That was Spenser, actually, a contemporary of Will's. But he makes a point. People evolve just as planets do."

"And sometimes we must help them along. Evolution seldom happens without effort, and the birth pangs of change are often violent."

"As time goes by, I wonder how I can even help myself along. All youth's ideals become focused through the lens of experience, as the wise man told us."

"But you still believe in battling injustice."

"Never without my armor, these days. And I scope out the battlefield first."

Dinh tilted her head to look at her college friend. "That does not sound like the Debs I knew. Something has happened to you."

"Many things have happened to me," Rabinowitz said softly. "Most of them named Mikhail."

Dinh looked at her intensely for a few moments, then just as intensely looked away. Yet another long, awkward silence until Dinh finally said, "You mentioned you found a murder victim, too. What was that like?"

Relieved to be on neutral ground, Rabinowitz related the story of her encounter on Jenithar and the subsequent events. She was just finishing the narrative when Detective Hoy rang the front bell.

William Hoy looked more his normal self now, impeccably dressed in an expensive suit, his hair neatly combed, his manner unflappable. Rabinowitz escorted him into the living room and introduced him to Bian Dinh. Hoy seemed definitely on top of himself, alone with two beautiful women.

"Nice to meet you, Ms. Dinh," he said. "I hope you don't mind my skipping the small talk, but the hour is unusual. Ms. Rabinowitz tells me you found a murder victim on a planet called K'tolu'tan. Was this someone you knew, or a stranger?"

Dinh sat at an angle to him, not looking at him directly. "His name is . . . was P'tar'houn-Hoc. I had met and talked with him several times before."

"How many is several?"

"Eight or nine, I think. I never counted. Why, is it important?"

"In my business, you never know. We can count later. What was your relationship with him?"

"Business. I am a writer, he was a publisher. He was commissioning a book from me."

Hoy glanced over at Rabinowitz. "Is Ms. Rabinowitz your broker?"

"No," Rabinowitz said quickly. "I didn't even know about it until she came here looking for help."

"I see. How did you happen to find—" His tongue struggled hopelessly with the name. "This person's body?"

"I teeped to K'tolu'tan, then hired

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an automatic cab to take me to his house."

"Was he expecting you?"

"Yes, I phoned him in advance. He told me to come."

"Was he dead when you got there?"

Dinh closed her eyes and looked away. "Yes."

"Did he live alone?"

"No, he had a wife and children."

"They let you into the house, then?"

Dinh hesitated. "I did not go into the main house. He told me he would be in a small private building behind the main house, where I have met him before. I went there."

"Did anyone see you?"

"I don't know. I made no attempt to hide myself. I had no reason to."

"Who let you into the smaller house?"

"I let myself in. P'tar'houn-Hoc had given me a passcode to get through his security. The door opened and I stepped inside. He was lying on the floor in a pool of blood with a knife stuck in his chest. I was so horrified I could not think of what to do. I off-teeped and shook for several minutes. Then I decided to call Debs. She always has good advice."

"'Debs'?" Hoy said. He looked at Rabinowitz, the trace of a mischievous smile on his lips.

"An old school nickname," she replied. "If you were old and schooled, you might be allowed to use it."

"Sometimes I feel positively ancient," Hoy said, "particularly when I'm jerked out of bed under false pretenses."

He turned back to Bian Dinh. "You said this was going to be a business meeting. Were you recording it, by any chance?"

"I was going to, but I hadn't yet turned the recorder on. I saw no reason to record my cab ride to his house."

"Why did you teep there instead of just veering?" Rabinowitz asked.

"P'tar'houn-Hoc preferred meeting in person. He thought it was more secure."

"And you say you off-teeped?" Hoy asked. "You just left your rented body standing beside the corpse? Have you gone back to see if it's still there?"

"No, I . . . I've been afraid to."

Hoy shrugged. "Understandable, I guess. Well, you don't have to worry about notifying the authorities. When they find that rent-a-bod and trace it back, they'll come looking for you soon enough."

"Still, someone should be told," Dinh said. "Who knows how long it may be before he is missed?"

"An honest, upright citizen," Hoy mused. "What a refreshing change. Yes, I believe I can get in touch with the proper people on . . . on that planet. Why do people insist on giving things such unpronounceable names? Anyway, I'm past my bedtime and since our lovely Ms. Rabinowitz shows little indication of hospitality—"

"The proper word is 'pity,'" Rabinowitz cut in.

"—I must be traveling homewards. May I give you a ride somewhere, Ms. Dinh?"

"She has to get back to her hotel in the City," Rabinowitz said quickly.

Dinh shot her a pleading glance,

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but Rabinowitz shook her head. "Sorry, Bian. I have that rehearsal in the morning that I just can't miss. There are other people counting on me, too. Tonight has been a big enough distraction. I'll call you as soon as it's over, I promise."

"Ms Rabinowitz can vouch that you're safe with me," Hoy said. "She knows I don't molest any principals in an ongoing investigation."

"Not physically," Rabinowitz agreed.

Dinh took the last sip of her hot chocolate, then slowly stood up and put on her coat. Hoy escorted her to the door and said, "That's my car over there. If you'll wait a moment, I just need a few words with Ms. Rabinowitz." Dinh nodded and walked down the front steps.

"You know, if this was my case she'd have to be right near the top of the suspect list," Hoy said when Dinh was out of earshot.

"Then I'm sure we're all glad it's not your case," Rabinowitz said.

"One thing more," he added. "On my way over here I flagged the system for your name. Seems you were involved in an incident of an alien going loono earlier this evening."

"Why yes, I still remember that. It was only a few hours ago. But how kind of you to remind me."

"It might amuse you to know that the alien who rented that body also came from K'tolu'tan. Gives one something to think about, doesn't it?" he said as he closed the door behind him.

Rabinowitz already had too much to think about. The first full run-through of any play was never less than traumatic, and the Scottish play seemed particularly cursed. She had, over the years, assembled as fine a crew as one could hope for in amateur theatricals, but all of these people had other things happening in their lives and could only devote so much attention to the play. Crises were inevitable.

She sat in the audience of the virtual theater watching it all unfold. Kwame Massala, her Mac, was the rock that anchored this production. He was superb, never a blown line or a misplaced cue. The only reason he was still working with an amateur group was that no professional company was willing to pay him more than he made as a stockbroker. Yet.

Her Lady M., Sally Rath, was a talented amateur but unlikely to make the jump to professional. She was decent in her soliloquies—but standing toe-to-toe with Mac, her deficiencies showed only too well. Rabinowitz was staging this to minimize the inequalities but, to her eyes at least, they were still there.

The rest of the cast ranged from good to unobjectionable. None of them could save a bad show, but none would cause a catastrophe, either. And behind everything was Rabinowitz's true star, Fran Bowd, the everywhere-at-once-and-never-in-the-way stage manager, sweeping up all the minor dilemmas before they became full-blown crises. Rabinowitz never wondered what she would do without Fran, any more than she wondered what she'd do without a kidney; she

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knew she'd cope, but it wasn't worth contemplating.

But as she sat in the audience trying to make notes, another figure intruded: her Gloucester, the ultimate clown in the ultimate black comedy. Twisted, perverted, sporting with the world that belittled him—Kwame could play him well, and Sally would make a splendid Lady Anne since she wasn't expected to stand up to him well.

"Was ever woman in this humour wooed?" Rabinowitz sighed. "Was ever woman in this humour won? Oh Will, you had such a dismal opinion of us sometimes . . . but your men weren't that much better, come to think of it."

She shook her head and looked back at the stage, where Banquo's ghost was currently spoiling Mac's party. "One royal murderer at a time, shall we? Let yourself be transported, woman."

She got through the rest of the play with only vile shadows of Gloucester intruding here and there, then called the cast around her and gave them her opinions. Even she didn't think the comments were up to her usually inspired insights. She chalked it up to a lack of sleep.

When the rehearsal was finally over and she disengaged the veering set, she found four messages waiting for her. Two were routine business calls, the third was from Bian Dinh asking to meet as soon as she finished rehearsal, and the fourth was from Detective Hoy. "I thought you'd find it amusing that the authorities on K'tolu'tan want to try your friend, Ms. Dinh. Not only for murder, but for 'perversion of common morality,' which seems to be almost as serious there."

"The problem," Hoy said when she called him back, "is that K'tolu'tan has always kept to itself. It has no 'mutual justice' treaty with us. We can't arrest her or force her to stand trial here. And even if she faces the charges on K'tolu'tan and their court finds her guilty, we're not legally obligated to enforce the sentence. The most they could officially do is bar her from teeping there ever again."

"Then she has nothing to worry about."

"I wouldn't say that. They could teep one of their own people over here to execute her and, by the same laws, we couldn't prosecute him. I'm sure you can see the diplomatic results."

"The reverberations could go on for years, maybe decades."

"That's just what my chief thinks. Interpol can't take this any further. Maybe you could."

"What do you expect me to do?"

"Something brilliant."

"Thanks, but my prescription for brilliant pills lapsed last month."

"Nonsense. You've got a background in interstellar diplomacy, you're used to negotiating on other people's behalf, you've even cracked a murder case. I'm sure you'll do almost as good a job as I could."

"You floor me with your confidence."

"I'll keep that in mind," Hoy smiled. "On the floor can be fun. By the way, do you know what sort of company

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you're keeping? Your Ms. Dinh has a rap sheet longer than a five dollar hooker's."

"All in college, lots of arrests, only a few convictions, all misdemeanors, mostly DTP and resisting, right?"

"You know her pretty well, I see."

"She was one of the firebrand radicals in college, both on Earth and at Polycultural Institute on Pna'Fath. Always agitating for some just cause, the more lost it was, the better."

"And what about you?"

"What about me?"

"I took the liberty of checking your college records, too. Everything except your class transcripts has been sealed shut. Officially, you're absolutely pure."

"That's me. I put driven snow to shame."

"Odd, don't you think, that such an innocent young girl was best friends with a hooligan like Bian Dinh."

"Not so odd, if you think about it. I talk to you, don't I?"

"If you want my help, Bian," Rabinowitz said. "I'll need facts."

"I have not lied to you," Dinh said, but she refused to meet Rabinowitz's gaze over the phone line.

"Partial truths are more misleading than lies. Or did you forget I grew up hosting diplomatic functions? Tell me everything about your relationship with this guy on K'tolu'tan."

"He was a publisher. He had read some of my works on the politics of food, and they spoke to the rebellious nature within his own soul. He wanted me to write a book specifically about the politics of food on K'tolu'tan."

"Did he reach you through your agent?"

"I'm . . . between agents at the moment. He contacted me directly. He said he would use the proposed book as a call to arms."

"The little bit of research I've had time for says food and eating are taboo subjects on K'tolu'tan."

Dinh nodded. "Totally. That was what was so wonderful. P'tar'houn-Hoc wanted to challenge the established order. Like us, he was a progressive thinker who believed in freedom of speech and ideas."

"Like us," Rabinowitz echoed with a trace of cynicism. "Were you involved with him personally in any way?"

Dinh looked at her, her face a mask of innocence. "What are you implying?"

"You're not the only one who remembers good old college days."

Having attended Polycultural Institute with Dinh for three years, Rabinowitz would have believed nothing could embarrass the other woman. Apparently she was wrong, for Dinh looked flustered as she said, "Do you know what K'tolu'tanou look like?"

"No, but I know what Reticuleans look like, and I remember that one weekend—"

"K'tolu'tanou look like soft-shelled crabs walking erect. If P'tar'houn-Hoc tempted me in any physical way, it was to throw him in a pot of boiling water and melt some butter when he was done. He stimulated me intellectually, yes, but that is all. We had many exciting conversations about the repressive nature of K'tolu'tan society—"

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"I'll bet you did. Is that what led to this charge of perversion they've got against you?"

"We never did anything," Dinh protested. "If my book had been written and published, it would certainly have perverted the common morality—but it never was."

"All you ever did was talk?"

"I prepared a few meals for him. He found that stimulating."

"Oh, I'll bet he did. You indulged his unique and culturally twisted fantasies—"

"They weren't unique. There is a worldwide underground society devoted to public eating. P'tar'houn-Hoc was one of its leading members. So was his assistant, F'tim-Saa."

"The plot thickens. You were involved with the local Hellfire Club."

"You make it sound so childish. There was a time you would have thought it was noble."

"Probably, in some distant epoch."

"Even if all you're thinking is true, I would have no reason to kill him. We held the same values, and he was commissioning a book from me. Surely you don't think I'd kill anyone."

"Not the Bian I knew in college," Rabinowitz admitted. "You might harangue someone to death, but that would be suicide if they stayed to listen. No, I don't think you could take a knife and stab someone. But somebody did kill him, and you're conveniently far enough away to make a wonderful scapegoat. People love to blame aliens when things go wrong."

"That reminds me of our march to protest the treatment of the Kaliwwan. Do you remember—?"

"Yes I do, and I'm proud I was part of it, but it has nothing to do with the case at hand. You said the door was locked when you got there. Do you know who else had passcodes?"

"No, I don't. His family probably did, but there could have been other people."

"Other members of his secret society?"

"Possibly. I didn't really meet any of them except his assistant. But the door locked when it closed. The killer could have been invited in there, killed P'tar'houn-Hoc and left, and the door would have closed behind him. He didn't need a passcode."

Rabinowitz decided to try another avenue. "Did he have any enemies?"

"We both spent much time condemning the forces of conservatism and repression, but he only mentioned one specific name, someone who was a bastion of hypocritical public morality."

Dinh closed her eyes and tried to think. "What was the name? It sounded something like 'cantaloupe,' but I don't remember exactly. P'tar'houn-Hoc said this person was giving speeches all the time, calling him names and urging his destruction. Sorry, but I don't know any more than that."

"That's fine, it gives us a motive. We'll let it simmer for a moment while we concentrate on something else. The murder scene. You said it was a smaller building behind his main house. What was it, a private office or den or something?"

"Actually, a kitchen and eating area."

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"I guess that makes sense. What was it like? Give me as much detail as you can."

"Not very large, sort of like the kitchen and dining area of a small efficiency flat. It was rectangular. The walls were sea green, and there were pictures of food on them. There was a phone built into one wall so he could conduct business while he ate. There was a countertop along one of the long walls with a small sink and several cupboards underneath it for storing dishes and food. Against the opposite wall was a small square table with two chairs. The counter and sink were to the left as you entered the room, the table and chairs on the right. There was only the one door, and no windows. That's basically it. Very simple."

"If it only were," Rabinowitz said with a sigh. "OK, what normally happened when you visited him there? You said you cooked him some meals."

"Prepared them," Dinh corrected. "I would add spices and things, but the K'tolu'tanou eat their food raw. Bunches of things like kelp and lots of fish and hard-shelled little creatures. I think some of them may have been alive, too. I hadn't had a chance to do much research yet, we were too busy talking about the sinister social repression. Anyway, P'tar'houn-Hoc would sit at the table and eat what I prepared while I stood beside the table and watched him. We would talk about my book, and how it would deal a crushing blow to the enemies of social progress. I asked him questions about—"

"You stood beside the table? I thought you said there were two chairs. Weren't you allowed to sit in his presence?"

"I don't think he would have minded—but he always sat in the big chair and I couldn't fit in the smaller one."

"A big chair and a small chair? What is this, 'Goldilocks'?"

"The second chair was like a child's highchair. My body didn't fit in it. Do you think it's important?"

"I don't know. Did they rent you the wrong size body?"

"They said it was the only size they had, but it wouldn't fit in that chair. I didn't mind, since I was just teeping. I could sit comfortably at home while the rented body was standing."

"Now think hard. Was there anything different about the room when you went there last night?"

"I didn't take much time to look around." Dinh closed her eyes to better visualize the scene. "The counter and sink area looked the same. Both chairs had been tipped over, and P'tar'houn-Hoc was lying beside his chair with the knife sticking in him. Now that I think of it, it was the same knife I used for cutting up kelp; there were ceremonial engravings on the handle."

She shook her head. "No, other than that everything looked as it normally did." She paused and looked into the phone at her old friend. "I haven't been much help, have I?"

Rabinowitz shrugged. "As Dostoevsky said, God sets us nothing but riddles. Sometimes we're lucky enough to find a few answers." She sighed again. "But sometimes it takes a lot more luck than others."

* * *

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The police on K'tolu'tan were not at all helpful. They would not transmit visually and refused point blank to answer Rabinowitz's questions—and once she explained she was investigating on behalf of Bian Dinh, they became downright rude. Even if she teeped to K'tolu'tan, Rabinowitz would not be allowed to inspect the murder site. She had no authority in this matter, and the police intended to keep it that way.

"Something brilliant, the man says," Rabinowitz muttered as she broke the connection. "I feel about as brilliant as a velvet rhinestone. Bian was always good at digging her own grave. I don't know if I can exhume her this time. I don't even know if I should bother."

Her computer reminded her she had a conference call scheduled, and for the next hour and a half she put her friend's problems aside to deal with her own business. She finished the call and started to make herself some lunch when the phone rang with a call from K'tolu'tan. She didn't recognize the person's name, but she took the call anyway.

"Shallow tides, Deborah Rabinowitz," said the person at the other end of the line. Dinh had been right; the K'tolu'tanou *did* look like soft-shelled crabs. "I am called F'tim-Saa. Your beloved, Bian Dinh, told me I must speak with you."

"My *what?*" Despite almost two decades of dealing with approximate translations over interstellar data loops, the term still caught her by surprise.

"'Beloved.' At least, that was how my machine interpreted Bian Dinh's word."

"I'd better have a talk with Bian," Rabinowitz muttered to herself, adding more loudly, "Does your machine have a term for old friend, comrade, buddy?"

"Yes, certainly."

"Well, those terms are probably more accurate these days. I presume your call has some bearing on the death of P'tar'houn-Hoc."

"I believe it does. I was his second-down, in charge of implementing his business."

"Ah yes, now I remember your name. Bian did mention you. You may turn out to be a godsend, someone who can fill me in on local customs and practices. Bian is very intelligent, but she has a tendency to leap into the middle of situations without fully analyzing them. Always with the best of intentions, but . . . well, I'm sure you understand the problem. Any help you can give me in understanding what's happening on K'tolu'tan will be greatly appreciated."

She paused. "Um, for instance, I apologize for my ignorance about your customs, but is there some honorific or title I should address you by?"

"A shortened form of my name, F'tim, will be quite sufficient."

"Thank you. And the same for me. 'De-BOR-ah' will do nicely. I'm trying, just as a friend with no official position, to find out what happened to P'tar'houn-Hoc. Having known Bian for many years, I honestly don't believe she's capable of murdering anyone. Do your police have any special reason for believing she did it?"

"They don't tell their minds to me, but I can guess. She's a stranger, an

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alien. She was in his private dining room beside the body."

"But no apparent motive whatsoever. Unless your world is vastly different from mine, mentally balanced people don't often kill one another for no reason at all. Did P'tar'houn-Hoc have any enemies?"

F'tim considered this. "As a successful business leader he had competitors, but none I believe who would do such a thing."

"Greed's always a good motive. Who inherits his publishing firm?"

"Since he had no heirs, I do."

"No heirs? Bian told me he had a wife and two children."

"Yes, but the only son is still very young and cannot legally inherit."

"What about the wife and daughter?"

F'tim seemed perplexed. "What about them?"

Rabinowitz paused to absorb that. "OK, that's the way it slides. I'll bet Bian didn't know about that, or she'd have been trying to reform more than your eating habits. What happens to the family now that P'tar'houn-Hoc's dead?"

"I inherit them as well," F'tim said.

"Indeed?"

"It is a heavy responsibility. I already have a wife and child of my own to care for."

"Do you get P'tar'houn-Hoc's entire estate?"

"I inherit everything that was his."

"I see." She paused for a long moment, then decided to change the subject. "What about the room where P'tar'houn-Hoc was killed? I understand from Bian that it was a combination of dining room and office."

"She would know better than I. I have never been there."

"Would there be any reason for his children to be in there?"

"I don't think so. There is a central room of the house where children are taught to eat, and once they are old enough to eat by themselves they are assigned their own private rooms." F'tim seemed uncomfortable with the subject, so Rabinowitz decided to move on.

"I understand P'tar'houn-Hoc wanted to commission Bian to write a book about the politics of food on K'tolu'tan," she said. "As his successor, do you plan to continue that commission?"

"I think it would be a worthwhile project, yes."

"Is it a matter of personal interest to you?"

One of F'tim's eyes wiggled on its stalk. "I think you are politely asking whether I share his interest in . . . public dining. That's not a question I can answer easily. Yes, I am a member of the Food Society, and yes, I share its goal of removing the stigma of eating in public. But that is where the similarity ends. With P'tar'houn-Hoc, this eating was an obsession, a fetish, a passion to defy the standards of decent society. I believe for him the Food Society was a way to justify his perversions, a rationalization of his sickness."

"I see . . . I think. But this isn't the case for you."

"Deborah, since I became old enough to feed myself, no one has ever seen me eat. I never took part in the Food Society's 'dinners.' The very thought fills me with revulsion."

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"I'm a little confused. If you don't like public eating, why are you in the Food Society? Was it just to please your boss?"

"No, though that was an additional benefit. I am . . . I don't know, an idealist, a revolutionary, a futurist. I see my world becoming a self-imposed outcast of galactic civilization. K'tolu'tan has little contact and less trade with other worlds, and it is no one's fault but our own. On all other worlds, eating is an everyday occurrence. People pay it little thought. Only on K'tolu'tan is it a monstrous perversion, and so we shut ourselves off. We pretend that if we have nothing to do with those other worlds, we don't have to think about their disgusting habits.

"I believe we are cutting ourselves off from our future. There is much we can learn from other people, and perhaps a few unique things of our own we can share. We don't have to surrender our own ways, but we must desensitize ourselves to the ways of others. I want Bian Dinh's book, not as a piece of personal pornography, but as a manifesto for change."

Rabinowitz laughed out loud. "You and Bian are a match made in heaven. I think you'll enjoy one another thoroughly."

Then she grew serious again. "Bian mentioned someone who gave a lot of speeches against P'tar'houn-Hoc, a conservative spokesman. She couldn't remember his name."

"Ah, yes. There is a prominent lecturer named simply K'anal'orb who has led many meetings against the sin of public mastication."

"A lecturer?"

"I suppose this time I am the victim of poor translation. A social leader without an official position, a public moralist, a person of supposed rectitude. K'anal'orb draws large crowds to his lectures and spurs them to emotional frenzies with his appeals to traditional social values. There are those who would walk through a desert for him. Because our firm has published books about eating, we are one of his special targets. He has lectured many times against us, and mentioned P'tar'houn-Hoc often by name."

"Sounds like an evangelist," Rabinowitz said. "You consider this K'anal'orb a suspect, then?"

"He has called for P'tar'houn-Hoc's destruction many times."

"Which is why I have doubts about him as a suspect. Moralists love having a bad example around to point to. P'tar'houn-Hoc was too valuable to him alive. His death can only be milked for one or two sermons on the wages of sin before it becomes stale and K'anal'orb has to look for a new target."

"Perhaps one of his followers became too enthusiastic."

"'Who will free me from this turbulent priest?' Deja vu all over again," Rabinowitz muttered, too quietly for the computer to pick up. "Can you think of anyone else with a motive?"

"No one to my knowledge."

"Well, keep working on it. Meanwhile we've got a trial to worry about. How does Bian get herself a lawyer?"

F'tim stared silently for a few seconds. "I'm afraid there is yet another translation problem. What should Bian try to get?"

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"Someone who is an expert on your legal system, who will represent her interests and defend her at the trial."

"There are scholars who analyze important cases throughout history. We've even published some of their books. I suppose they are experts. But they don't defend anyone."

Rabinowitz started to get a sinking feeling in the pit of her stomach. "How do your trials operate?" she asked very slowly.

"The accused person is brought to an assembly hall. People who have complaints state them and the accused person tries to explain. When everyone who wants to has spoken, a vote is taken and the decision is rendered."

"Who gets to vote?"

"Anyone who's there."

"Good Lord," Rabinowitz muttered quietly, closing her eyes. "They may look like crabs, but it's going to be a kangaroo court!"

"So you won't believe I was just in the neighborhood and decided to drop in?" Detective Hoy asked.

"The Bay is a couple of blocks that way," Rabinowitz said. "Drop in there."

"How inhospitable. And just when I came all this way to help you."

"The way you helped me by dumping this problem in my lap?"

"Excuse me? Who dumped what? I seem to remember a late night 'life-or-death' phone call. It's not *my* old college chum trying to pervert the morals of an entire planet."

"Look, I just learned what trials are like on K'tolu'tan and I'm feeling pretty crabby. I'm staging the Scottish play, I'm dreaming *Richard III*, and now I've got to go star in *The Merchant of Venice*. Not to mention any of my real work, which is hanging in midair while I juggle all the other pieces. I don't have time to watch you practice your boyish charm."

"Not even if I brought you something to help you?"

"Like a notarized confession from P'tar'houn-Hoc's killer?"

"Maybe as good." He took a paper from his jacket pocket. "This is the rental slip for the robot that attacked you the night of what's-his-name's murder. It was paid for from the account of someone named K'anal'orb. I understand he's a high-soaring preacher or something."

"Do the authorities on K'tolu'tan know about this?"

"Where do you think I got it? They've even questioned him about it. He claims he was preaching in front of a thousand people at the time of the attack. Some flimsy alibi like that."

"Then how did his account number get attached to the rental?"

"He has a whole staff of adoring followers running his organization. He says there are something like thirty people authorized to use his account. From what I gather, the police haven't checked more thoroughly than that."

"So we've just added thirty suspects. What good does this do me?"

"Maybe you can try to introduce some reasonable doubt. At any rate, it might give you something to zero in on."

"The trial is tomorrow morning. The only thing I'll zero in on is your

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head if you're not out of here in thirty seconds."

Hoy smiled. "I go, I go; look how I go."

She stared, bemused, as the door closed behind him. "The boy's learning something. I may civilize him yet."

The recording arrived two hours later. She had asked F'tim to send her a holo of K'anal'orb in action, and F'tim had assured her such recordings were readily available. Although she had no way to know for certain whether K'anal'orb would attend the trial, it seemed a pretty safe bet he'd want to milk this for everything it was worth. And since the verdict was by majority vote, he'd pack the courtroom with as many of his followers as possible to guarantee the outcome he wanted: death to the alien subverter.

Rabinowitz sat behind her desk, lowered the lights in her office, closed her eyes and meditated for a couple of minutes. Finally, as ready as she'd ever be, she started playing the holo to look into the face of the enemy.

The scene was a circular outdoor arena at night. Blazing torches ringed the perimeter, but spotlights lit the stage in the center. It cheered her slightly to note that the crowd was barely half the arena's capacity; K'anal'orb might be popular, but he couldn't automatically pack an entire house. Rabinowitz gauged the attendance at less than a thousand, but was willing to bet they made up in intensity what they lacked in numbers.

Clothing seemed optional, serving mostly to keep out the nighttime chill; some people wore cloaks, some had small bands of cloth on their shells, and other hardier souls had only painted patterns or jewelry. There was no seating and everyone was in constant motion. It was apparently expected that the audience would mill about and talk to their neighbors, at least before the show. It reminded her of the groundlings at the old Globe, except that this audience was above the stage on the sloping sides of the bowl. "I guess this restores the meaning of the word 'stands,'" she muttered.

There was a bustle of activity around the stage. Rabinowitz's trained eyes could spot a small army of stagehands moving purposefully in the shadows, tending to the million and one details a live show of this sort required. Each helper was easily identified by an aqua-colored sash worn diagonally across the shell. As she looked more closely, Rabinowitz could see more of the helpers moving through the audience and talking with people, probably encouraging their enthusiasm.

There was a rising sense of anticipation swelling within the crowd, so when loudspeakers blared a six-note fanfare and the lights on the stage dimmed, then rose, the people turned all their attention to the center. On stage stood a K'tolu'tano Rabinowitz would have been unable to tell apart from the others except that his somber gray robes wrapped with dignity around his body. He stood stock still, waiting for the new tension to build. The audience continued to mill about silently, a backhanded tribute to Brownian motion, but they moved

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much more slowly now, their eyestalks all fixed on the one individual.

Rabinowitz watched K'anal'orb move around the platform. The speaker would turn his attention in different directions as he spoke, managing to face each section of the audience around him at least once every couple of minutes—classic theater-in-the-round staging. She watched his body rhythm, saw how his movements followed a silent three-beat melody that started slowly and increased gradually to a breathless pace; then, with one dramatic gesture, he would wave an arm and bring the tempo to a flashing halt that left the audience panting before he started slowly to build the pattern again. She listened to his voice, both the modulation and the cadence, perfectly synchronized to his movements around the stage—again carefully calculated to carry his audience on an emotional roller coaster.

"Too repetitive a pattern," she muttered. "He'd lose a human audience after a while. But if the K'tolu'tanou evolved along a shore with strong wave action, it might hit some primordial instinct. Yeah, it probably works for them."

The show lasted less than an hour; then the spotlights went out briefly and came back on to brighten an empty stage. The audience was screaming its approval, its hunger for more—a hunger K'anal'orb would not satisfy until his next performance. He knew how to keep his fish on the hook.

Rabinowitz watched the holo the first two times without turning on the translator. She didn't have to know the words K'anal'orb was saying to understand what he meant, any more than she needed to speak German to hear the message of *Triumph of the Will*. When she did finally turn the translator on, she knew she was right; the speech itself was little more than vague generalizations. The delivery was what sold it.

She leaned back in her chair and closed her eyes. "A consummate performer," she said. "Kwame could match him for eloquence and passion, but he doesn't improvise well and we can't expect K'anal'orb to stick to our script. Besides, I doubt Kwame's ever teeped in his life, certainly not into an alien body. It wouldn't help his performance to be floundering out of control around the stage."

She sighed. "Might as well face it. As an actress, Ms. Rabinowitz, you may only be a mediocre understudy—but for this one show, you'll have to give the performance of your life."

Everything was falling apart, yet still he chose to face the world bravely. Villain though he might be, he had a vestige of manhood and pride.

". . . And now a wood/Comes toward Dunsinane. Arm, arm, and out!/If this which he avouches does appear,/There is nor flying hence nor tarrying here./I 'gin to be aweary of the sun,/And wish th' estate o' th' world were now undone./Ring the alarum-bell! Blow, wind! come, wrack!/At least we'll die with harness on our back."

Yet even as he mentioned his back, it began to change, to shift, and Mac leaned forward, unable to keep up-

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right. The gray stone battlements vanished, to be replaced by the charred beams of the burned-out Globe Theatre, and she found herself staring into the leering face of Gloucester just as he learned that Richmond had put upon the sea seeking to topple his throne. His eyes burned with passion as they glared unwaveringly into hers.

"Is the chair empty? is the sword unswayed?/Is the king dead? the empire unpossess'd?/What heir of York is there alive but we?/And who is England's king but great York's heir?"

The alarm chimed and Rabinowitz woke in a cold sweat, still feeling the glare of those cold, mad eyes. "Why did he look at me like that?" she muttered. "That's not the way I directed it. Was he trying to tell me something?"

She yawned despite her tension and rubbed her eyes. "Yeah, right, I'm getting omens in my dreams. He's probably warning me I'm facing as big a disaster as his. Why couldn't I have gotten Caesar's soothsayer? At least he said exactly what he meant. Of course, not being as evil as Richard may mean I have some justice on my side.

"But," she reminded herself, "in the course of justice, none of us should see salvation. We do pray for mercy—Oh damn, what's the rest of it? I'd better know *that* one by heart. And who cares if I'm giving away precious literary assets? It's fair use, and it'll just whet their appetite for more."

She glanced at the clock: 4:31 A.M. "Time to go." She went to the bathroom, ran a comb quickly through her short brown hair, donned a warm flannel robe and went downstairs to her office. "Phone: call Bian Dinh. Time to wake her for her appointment with Destiny."

But Dinh wasn't sleeping. She, too, was pondering the trial, though she had an entirely different perspective on it. "This will give us a wonderful platform to expose the weaknesses of K'tolu'tan morality," she bubbled at her friend. "Just like the Scopes evolution case, my innocence will vindicate me and show what hypocrites their moral leaders are."

"But Scopes was guilty," Rabinowitz reminded her. "And he wasn't facing a murder charge with no other suspects available."

"Such details won't matter when I present my case. I will expose the corruption and oppression in their society—"

"You will keep your damn mouth shut is what you will do. The last thing we need is you telling an already biased jury what idiots they are. The cards are stacked against us and I don't know whether we're playing bridge or poker—but if you still want my help, you'll play by my rules."

Dinh flamed. "I will not be gagged, and especially not by someone who's abandoned all the noble ideals we both once held so sacred."

"Good. I didn't want to go to court today anyway."

She started to switch off the phone when Dinh reached out to the screen and said, "Debs, wait."

Rabinowitz waited, staring at the screen in silence.

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"You would really leave me to face the court alone? Debs, I can't do it without you. I never could. Together we can slay dragons, but without you . . ." Her voice broke. "I do need your help."

Rabinowitz softened. "Then let me give it to you the best way I know how. Maybe my tactics have changed since we last rode out against the windmills—but maybe I've learned a few things, too."

Dinh gave her the telepresence address of the body rental agency she used on K'tolu'tan, and the women each established their connection to the shop. K'tolu'tan didn't have much TP traffic, and their choice of bodies was decidedly limited—one basic shape, any of three nearly identical shades of beige, fashioned from some lightweight metal alloy. As Rabinowitz joined with the robot she chose, it was as though her body shifted.

K'tolu'tanou bodies had an odd symmetry. They were bilaterally symmetrical about a horizontal axis drawn across the middle of their shells, with three limbs on each side of the axis. The three limbs at the bottom had evolved into short, powerful legs; the middle one could stretch to make a tripod for balance. For someone who could only use two legs at a time, the center of balance was all wrong; Rabinowitz felt top-heavy, and was positive that leaning forward would prove disastrous. She was only too happy to give herself over to the automatics that translated her two-legged walk into the K'tolu'tanou mode. She moved very slowly in a gait halfway between a drunken lurch and a sailor's rolling swagger, but at least she was in little danger of falling over. Remembering the clumsy alien who'd attacked them at the banquet, she was grateful for small favors.

There were only two eyes, one on either side of the imaginary axis, but they were at the right side of the body, and on long stalks. She felt as though she were looking at the whole world cockeyed—and the automatics took a long time to learn how to interpret her eye movements to move the eyestalks. "With limited outside contacts, they don't bother investing in good software," she muttered. It was almost easier to turn her entire body around to change her field of vision—an awkward procedure at best.

Her arms were less of a problem. The one closest to the eyes had a big claw that let her snap at things and hold them steady. Inside the claw was a retractable three-fingered hand. The middle arm had two elbow joints and was long enough to work in concert with the claw; it also had a serviceable three-fingered hand at its end. The third arm could not reach the claw, but had eight long delicate fingers that allowed fine manipulation.

She snapped the claw hard a couple of times and fantasized about a few necks she would like to catch between those pincers. "Almost worth it," she muttered.

The ground was firm but not hard, like densely-packed wet sand, even inside the building. Dinh, who'd had more practice with this type of body, gave her pointers on how to move. Rabinowitz practiced walking around, coordinating her arms with her movements and turning her entire body just

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to see things at a different angle. "Maybe the jury will take pity on us because we look so crippled," she told her friend over their private phone connection. "Or maybe they'll be too busy laughing to care about the case."

"I've never seen a K'tolu'tano laugh," Dinh said solemnly.

"Not a good sign," Rabinowitz said. She tried to shake her head, but the motion didn't translate to the rented body.

The police were waiting in the agency lobby to escort them to the courtroom. The police car, which looked like a miniature barge and rode on an air cushion just a few centimeters above the ground, set off at an amazingly slow speed. "If this is the way they all drive," Rabinowitz commented to Dinh, "they must not have many serious accidents."

It was daytime here, with a dim red sun giving feeble illumination; it took a few seconds for the computer to render the "false color" imaging best adapted to human sight. This region was not densely populated, nor were the buildings very tall; Rabinowitz saw nothing higher than two stories. She got the unmistakable impression of beach front property. The robot body conveyed odors only for smoke and corrosive chemicals—scents representing immediate danger—but Rabinowitz's mind kept imagining the salty tang of an ocean breeze.

The police car pulled into a lot with other parked vehicles, all with the same lack of style and design. The police helped the two women out of the car and led them past a line of other people into a nondescript two-story building. They were instantly noticed; their artificial bodies and clumsy gait obviously proclaimed them aliens. The crowd went silent around them and parted to let them through, as though no one wanted to be tainted with the touch of alien corruption. Rabinowitz and Dinh walked straight ahead behind their police escort, ignoring the unfriendly stares.

Their destination became obvious as soon as they entered the building: spectators were moving toward one room like a line of ants to a fallen ice cream cone. Again, all movement stopped as they passed, and Rabinowitz had to work hard not to feel self-conscious about her awkward mechanical stagger. Only the fact that she'd done a variation of this so many times on so many different worlds let her keep her perspective.

There were no special tables or stands laid out for prosecution or defense, but the police led them down into the pit and then took up positions behind them. Placing the audience around the defendant made for better drama—and also better aim. Rabinowitz wondered what the local equivalent was for rotten fruit.

A K'tolu'tano standing down on the stage saw them enter and came quickly up the aisle toward them. "I am F'tim," he said, aware that the humans probably couldn't tell one K'tolu'tano from another.

Rabinowitz kept an eye on the rows as they filled with spectators. "There weren't any seats in the amphitheater in the holo you sent me, either," she remarked to F'tim. "Don't you people ever sit down?"

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F'tim seemed somewhat embarrassed by the question, but Dinh spoke up immediately. "They only sit while they're eating. Sitting has obscene social connotations."

"Hmm. That's interesting."

"Why?" F'tim asked. "In what way?"

Rabinowitz hesitated. "I'm not sure, really," she replied. "It just sounds like it should be."

"I plan to devote an entire chapter to it," Dinh told her. "It's highly symbolic of the entire culture."

"Perhaps." Rabinowitz said absently. She filed the information away in the back of her mind. There were too many other things to concentrate on at the moment.

The crowd continued to file into the room. Rabinowitz noticed several dozen people wearing the aqua-colored sashes of K'anal'orb's aides. She didn't have enough experience to recognize individuals of this race, yet, but she was sure K'anal'orb himself was somewhere within the audience, waiting for the right dramatic moment to come forward and take the stage.

The doors were closed when the room was filled to capacity, leaving the rest of the bystanders reduced to viewing the trial broadcast. F'tim assured her this was the largest courthouse in the area, but some trials were so notorious that not everyone who wanted to affect the outcome could fit inside.

"That's OK," Rabinowitz said. "I'm sure K'anal'orb has packed enough of his supporters in here to guarantee a guilty verdict."

A clerk with a green ribbon around his shoulders stepped forward and read the charges aloud: that the alien known as Bian Dinh conspired with the deceased, P'tar'houn-Hoc, to subvert the public morality and then, for reasons unknown, murdered him in his private dining chamber.

A policeman next explained that P'tar'houn-Hoc's body was found lying on the floor of his dining chamber with a knife in his chest, and that the alien body Bian Dinh had rented was standing over the corpse. Rental agency and cab records proved that Bian Dinh had indeed rented the body and traveled to P'tar'houn-Hoc's house at about the time the killing occurred.

The policeman withdrew, and a strange silence fell over the courtroom. "Well," Dinh said, prodding her friend over their private phone link. "Aren't you going to say anything?"

"I want to let them take the first shot," Rabinowitz replied.

It wasn't long in coming. Rabinowitz had half expected K'anal'orb to let his lieutenants take the first few easy jabs, have her rebut them, and then come out personally to deliver the big blows. But apparently K'anal'orb wanted all the glory for himself, because he strode arrogantly onto the stage amid the worshipful sighs and mutterings of his followers. He made an expansive gesture to acknowledge the crowd, and received a hissing/humming sound that served as applause on K'tolu'tan. Patently ignoring the rented alien bodies, he spoke directly to the audience.

"Too long have we allowed our world to be corrupted by the evil, perverse teachings of disgusting outsiders, who mock our honored cus-

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toms and lead us into the ways of degradation. They flaunt their perversions in our faces and demand we join them in their decadence. It is the ultimate irony, then, that P'tar'houn-Hoc, a blaspheming convert to their warped and twisted values, became a victim to their sickness and died at the hand of that murdering alien garbage."

"Feel free to defend me any time," Dinh said over their private connection.

"Just a little bit longer," Rabinowitz said. "K'anal'orb works to a specific rhythm in his speech. If I wait till he gets nearly to the peak of an emotional cycle and then interrupt, it'll come crashing down and it'll take him that much more work to build it up again."

She kept her ears carefully tuned, only half-listening to the actual words, until she felt he was nearly ready to smash his point home. Then she stepped awkwardly forward, waved her claw about feebly and shouted, "No, this is wrong!"

K'anal'orb stopped in mid-sentence and seemed lost for a moment. He was obviously unused to interruptions. He turned to glare at Rabinowitz's ungainly rented body. "See how one of these loathsome creatures comes to mock our very system of justice," he sneered.

"I've come here because I respect your system of justice," Rabinowitz replied. "My name is Deborah Rabinowitz, and I am a friend of Bian Dinh who has been accused of this terrible crime. Like yourselves, I seek to unmask falsehood and bring the truth to light."

"And yet you rudely interrupt the speech of an honored man," said someone from the crowd—someone wearing the aqua sash of K'anal'orb's disciples.

"If my action caused offense, it was merely through ignorance and not disrespect. I spoke as I did because I believe K'anal'orb is a man who also seeks the truth and who would like to be corrected when he himself delivers offense out of what I'm sure is ignorance rather than disrespect."

K'anal'orb had probably expected some kind of rejoinder, but not one with this slant. He hesitated, and Rabinowitz pressed her point.

"It's true, Bian and I are aliens. We were born on another world, our natural bodies take other forms, and we were raised to think in other ways. But that just makes us different, not evil. Don't condemn an alien just for being alien. Has not an alien eyes? Has not an alien hands, organs, dimensions, senses, affections, passions? Fed—" She paused abruptly, realizing that line might get her in trouble in a society that considered eating a taboo subject, but recovered quickly.

"Are we not hurt with the same weapons, subject to the same diseases, healed by the same means, warmed and cooled by summer and winter as any K'tolu'tano? If you prick us, do we not bleed? If you tickle us, do we not laugh? If you poison us, do we not die?

"We may be different, but we share many values with you—two of them being a reverence for life and a passion for the truth. We are as shocked as you are by this killing, and we

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come here, as you do, to search for the truth."

The crowd moved restlessly, not accustomed to having their prejudices upset this way. Rabinowitz wished she was a more dynamic actor, but trusted to the strength of the Bard's material to make its own point.

K'anal'orb, too, could see that some in the audience were starting to think, and that was not part of his plan. "A pretty speech," he said sarcastically, "but it cannot cover the fact that a life was taken. It cannot replace *their* loving husband and father."

He gestured across the room, and a group of his followers parted to reveal three small bodies standing apart from the crowd. Beside her, Rabinowitz could see F'tim react with surprise. "Who are they?" she asked him.

"P'tar'houn-Hoc's family," he told her. "I thought they were safely at my house. K'anal'orb's followers must have brought them here after I left."

"I thought P'tar'houn-Hoc only had two children."

"He did. The one in the middle is his wife."

Rabinowitz looked at the central figure, who was no larger than the ones flanking her. "He married a midget?"

F'tim sounded confused. "Et'fhan is a full-grown woman."

"But everyone else in the room is—" And then she stopped as the realization hit her. Women on K'tolu'tan could not inherit property; they were themselves property to be inherited. Physically, they were barely half the size of full-grown males. She was dealing with an all-male culture, an all-male audience. Did they know she was a female? If so, would they listen to her? Did they know Bian was a female? If so, did that somehow make her alleged crime even worse?

And as this revelation came to her, she knew there was something else, but she couldn't put her finger on it. It was fluttering around the back of her mind like the little Tinkerbell light fluttering around the Darlings' bedroom. The more she tried to catch it, the more it danced merrily out of reach—and she couldn't concentrate on it, because too many other things were going on at once.

K'anal'orb was talking again, starting to rebuild his rhythm and his momentum. ". . . all the flowery phrases cannot disguise the fact that the alien was the one plotting with P'tar'houn-Hoc to write the pornographic book, the alien was the one attempting to corrupt the public morals, the alien was the one standing over the body when it was found lying in a pool of blood—"

Dinh started to say something, but Rabinowitz quickly cut her off. "We have never denied that Bian went to the house at about that time. But the murderer had already been there and left. Bian was so shocked by what she'd seen that she broke the telepresence connection and returned home in a panic.

"But let me tell you all about another event that happened that night, an event most of you are unaware of. Bian and I were together on our world at a . . . public event, when suddenly we were attacked by an alien's rented body. We have many witnesses

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that this alien attacked us, but we fought it off. According to the records from our police, the alien who rented that body came from right here on K'tolu'tan—and the charge account used belonged to none other than K'anal'orb himself."

A buzzing went through the audience, but K'anal'orb was well prepared to parry this thrust. "Yes," he said casually, "the police indeed questioned me about this. At the time this attack occurred, I was on stage lecturing before more than five hundred people. I could not possibly have committed such a preposterous act."

"I don't need to believe that K'anal'orb would dirty his own hands with such a deed. He has many assistants, and even more ardent followers, all of whom would be more than happy to do his bidding. His hatred of all things alien has been quite evident here today. He ordered one of the faithful to kill Bian—"

"Lie!" K'anal'orb bellowed.

"—and when that failed, he ordered the murder of P'tar'houn-Hoc instead."

"Lie!" K'anal'orb repeated, even louder.

"Did you have to offer him money," Rabinowitz continued relentlessly, "or were spiritual rewards enough?"

She tried to wave her claw at K'anal'orb, and nearly unbalanced herself. She resolved not to overdo the dramatic gestures. "There!" she exclaimed. "There is the man ultimately responsible for the murder—the man who so adamantly insists on placing the blame elsewhere. K'anal'orb. He alone is responsible."

One of the disciples in an aqua sash leaped forward onto the stage. "No, he is innocent," he declared. "It was I, and I alone, who did these things. K'anal'orb is innocent. I am the one you seek!"

The courtroom was thrown into turmoil at this new and unexpected development. The man, whose name was Ari'stoc, described how K'anal'orb's speeches about the vile alien had so inflamed him that he was determined to silence her. He called Earth and saw the message on Dinh's service—a holo of her explaining she'd be at a public eating ritual. As a member of K'anal'orb's inner circle he had the use of the charge account; it was an easy enough matter to teep to Earth, rent the alien body and then find Bian Dinh at the ritual. He described the attack in such detail that Rabinowitz was convinced he was indeed the perpetrator.

He grew more vague, though, when he came to the description of P'tar'houn-Hoc's murder. He merely said that he realized P'tar'houn-Hoc was the ultimate culprit and that if he was silenced, the book project would come to an end. He went to the victim's home, had an argument with him about the book, stabbed him, and then fled back to K'anal'orb's contingent.

"Well, I've heard enough," Dinh said on the private channel. "The true murderer has been unmasked and I will be cleared of these ridiculous charges."

Rabinowitz was standing still, trying to concentrate. "It's not right," she muttered.

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"Of course it's right," Dinh insisted. "P'tar'houn-Hoc was murdered by the conservative forces of repression, as we've always said. We can go home now."

"Do you want this imbecile to become a martyr? That's what K'anal'orb will turn him into."

"Debs, he *confessed*."

But Rabinowitz ignored her and turned instead to face the crowd. "I would like to ask this man some questions."

K'anal'orb looked outraged. "You have no further interest in this matter."

"As I said, my people have a passion for the truth, which I haven't completely heard here."

"I warn you, Deborah," F'tim whispered beside her, "don't go further with this. Leave well enough alone."

Rabinowitz ignored him, too. "Ari'stoc, can you please describe in detail the room in which the murder took place?"

The self-confessed killer became hesitant and confused. "It was a very ordinary room. There was a table there for eating. The knife was lying on it. We argued, I picked up the knife and stabbed him. I was in a very agitated state. I can't remember more than that."

"How did you know where to find him?"

"His . . . his address was listed in the public directory."

"But you didn't go to the door of his address, which would be the logical place. No one mentioned seeing you. How did you know to go directly to the private dining building behind the house?"

Ari'stoc was silent for a long moment. "Well, where else would he be, a man like him—?"

"I'm sure even a man of his proclivities doesn't spend all his waking hours in a dining room. And the door was locked. It had a private passcode. How did you get in?"

"He . . . he let me in."

"Just like that? You, a total stranger in a very agitated state, and he just lets you into the most intimate room of his home?"

"Debs, what are you doing?" Dinh asked, frightened.

"I threatened him," Ari'stoc replied. "He was safe behind a locked door."

"I mean, I threatened his family. I said I'd hurt them if he didn't let me in."

"He had a phone in the room with him. He could have called the police and stalled for time. But he made no such call."

"He . . . I . . . " Ari'stoc was clearly going into mental vapor lock. Rabinowitz turned her body slightly so she could catch a glimpse of K'anal'orb. He was not at all pleased with her. If he couldn't convict a perverted alien for the crime, the next best thing would be to hold someone up as a martyr, someone who murdered an evil man to keep the world pure. But even that was being taken away from him.

A vision of her Gloucester came unbidden to Rabinowitz's mind. Well, with his crab-like posture, K'anal'orb did sort of look like a hunchback. But at the moment he was the cornered Gloucester, realizing things might not always go his way.

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Is the chair empty? is the sword unswayed? Gloucester asked.

"The chair," she muttered suddenly. "Of course. The chair."

She turned to F'tim, so abruptly that she almost fell over. "Were there any females in this Food Society of yours?"

F'tim recoiled in horror. "Of course not."

Rabinowitz turned more slowly back to face Ari'stoc. "I am convinced," she announced loudly, "that you did indeed commit the attack against Bian and me on Earth—but I'm equally convinced you had nothing at all to do with the murder of P'tar'houn-Hoc."

"Debs," Dinh pleaded on their private channel, "if he didn't do it, then I'm back to being the main suspect."

Rabinowitz looked over the crowd until she saw the police officer who'd given the earlier testimony. "Officer, who reported the murder to the police?"

"The victim's wife."

"So she was the one who discovered the body?"

"That's what she told me."

"Could you refresh my memory? How many chairs were in the room of the murder scene?"

"Two, a man's chair and a woman's chair."

"Thank you." She turned around to face a different part of the crowd. "Given what I've been told of your people's beliefs and habits, I find it extremely odd that P'tar'houn-Hoc had *two* chairs in such an intimate and private part of his home."

K'anal'orb spoke up. "Odd, definitely, but not unexpected. P'tar'houn-Hoc was a notorious pervert."

"But why a woman's chair? There were no women in his Food Society. Why would he keep a smaller chair in that room unless he had a regular need of it?"

She turned again, this time to stare at the widow. "You, madam, discovered the body. That means you knew the passcode."

Et'fhan spoke for the first time, very quietly and hesitantly. "It was part of my house. I was responsible for cleaning it."

"I think you entered that room often to do far more than clean it."

"You are impugning the virtue of an honorable woman," K'anal'orb protested.

Rabinowitz continued on. "I believe you dined in that room, madam. I believe you dined there regularly in the company of your husband."

Et'fhan seemed frozen, unable to speak. Rabinowitz pressed her momentary advantage. "I think you actually enjoyed it. I think you share your husband's perverse eating habits. You ate there with him because it gave you pleasure."

"No, no, he forced me. He made me eat with him in that room. I didn't want to, but I had no choice. I was his wife, I had to do what he told me. It sickened me. I hated it, I hated him!"

"You hated him because he made you perform horrible, disgusting acts."

"Yes!"

"You hated him because he enjoyed degrading you in sick and perverted ways."

"Yes!"

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"You hated him so much that eventually you couldn't stand it any longer, so you grabbed the knife and plunged it into his chest to make him stop degrading you, defiling you."

"No, that's not why!" Et'fhan screamed. She dropped to the ground, her body trembling in what Rabinowitz assumed were sobs. "That's not why."

The courtroom was deathly quiet. No one moved or spoke; all attention was focused on the prostrate form of the sobbing woman. After a minute or so she looked up again, regaining some of her composure. "If . . . if it were just me, I could have coped. I know what my duty was to my husband and I would have done it, shameful as it might be. But our son . . . he told me he was going to start bringing our son in there, to teach him those disgusting ways. Our son is so good, so innocent. I couldn't . . ." Her voice broke.

"You couldn't let your son be corrupted that way," Rabinowitz said in a much gentler voice.

"No," Et'fhan said, barely audible.

To his credit, F'tim was the first one to cross the room and comfort the woman he'd inherited as his responsibility.

Dinh was sulking in the cab they had to take back to the rent-a-bod agency, since the police were no longer escorting them. Rabinowitz could stand the cold treatment only so long, then said, "All right, Bian, out with it. What's your problem?"

"You had no right to do that," Dinh said curtly.

"Do what? I proved you were innocent, just like you asked me to."

"You let them off the hook."

"Them?"

"The forces of repression. We had a full confession. We could have pointed to them and shown how evil they are. Then you have to throw it out and prove the wife did it. What good does that serve? Do you really think she'll be punished?"

"Not after K'anal'orb finishes making her a hero."

"Exactly. We could have used that confession to tear down the villains. Instead, they'll come out of this even stronger."

"But it just happened to be the truth."

"The truth?" Dinh laughed bitterly. "The truth is that P'tar'houn-Hoc would be alive today if their society wasn't so repressed. After this case, it'll be harder than ever to change that."

Rabinowitz could hold her temper no longer. "Your problem, Bian, is you've got your priorities ass-backward. Your buddy P'tar'houn-Hoc was not just a pervert, he was a spouse abuser—and his wife killed him to stop him from abusing a child as well. If you want to fight for an underdog, fight for the women of K'tolu'tan who have no rights, who have to suffer whatever abuse their men dole out and get passed from hand to hand like spare change."

"Debs, I—" Dinh started to say something, stopped, and was silent for a moment. "I just can't talk to you any more," she said at last.

The rest of the ride passed in silence. They turned in their rented

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bodies and switched off their teepers, returning each of them to their individual rooms.

Rabinowitz sat for a long time, breathing slowly and deeply and staring unseeing at the far wall. Finally she gave a deep sigh and clapped her hands together. "When shall we two meet again? When the hurly-burly's done, When the battle's lost and won. Well, Bian, so much for hurly-burly, so much for winning and losing battles."

She stood up and stretched, luxuriating in the feel of her own arms and legs again. She'd been in worse bodies, but not many and not for a very long time. "Phone: messages."

Fran's face filled the screen. "Hi. Kwame and Ricardo decided to practice their swordplay in some virtual gym without telling anyone, and Ricardo tried a Douglas Fairbanks over the banister edge and strained a tendon. I didn't think you'd want a limping Duncan, so I found a software interface that translates the limp into a normal walk, sort of. *I* think it looks passable, but you're the director so you'll have to take a look. Oh, and Kwame's depressed because he thinks he caused the injury, and he won't listen to me so you'll have to talk him out of it. Maybe the Scottish play wasn't such a sly idea, after all." *Beep.*■

Editor's Note: This story is a sequel to "The Height of Intrigue," in our November 1994 issue.

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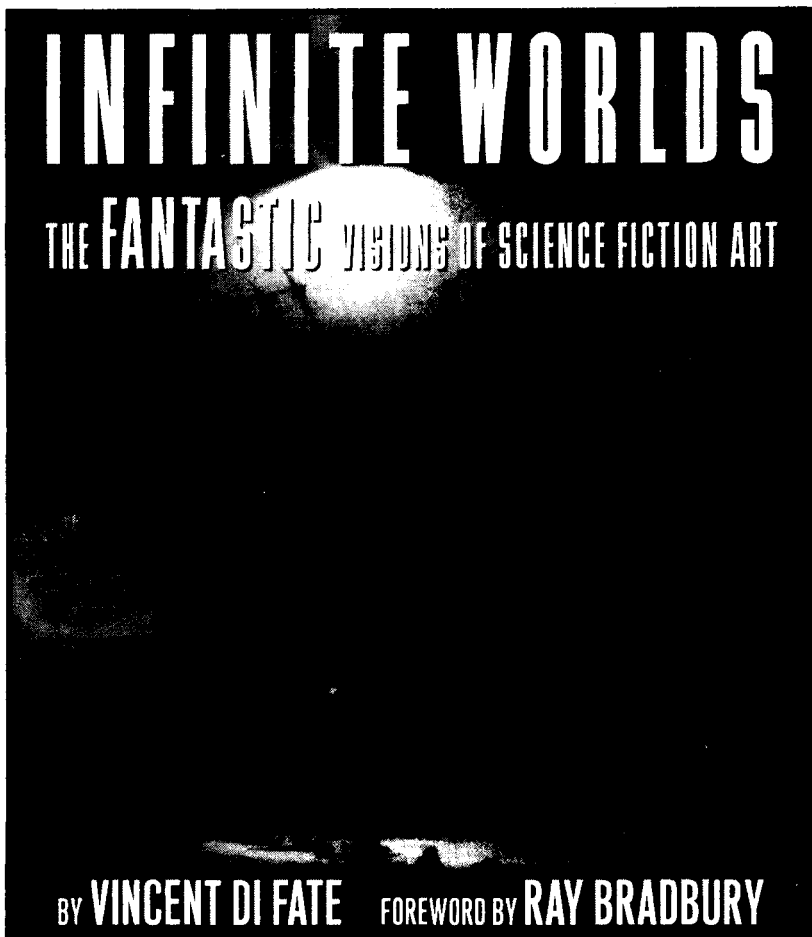

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The Quest for Alien Planets: Exploring Worlds Outside the Solar System, Paul Halpern, Plenum, $27.95, 293 + xxvi pp. (ISBN: 0-306-45623-0).
The Case for Mars: The Plan to Settle the Red Planet and Why We Must, Robert Zubrin with Richard Wagner, The Free Press (A Division of Simon & Schuster Inc., 1230 Avenue of the Americas, New York, NY 10020), $25.00 hardcover, $13.00 paperback, 328 pp. (ISBN: 0-684-82757-3). (Reviewed by Stanley Schmidt)

In the Middle Ages, there lived an alchemist, astrologer, and magician named Johann Faust (c. 1480-1538). The name appears also in the Medieval legend of a man who sold his soul to the Devil in return for knowledge and power, and again in an 1831-32 tragedy by Goethe and an 1859 opera by Gounod. The Faustian tale has resonated through the dawn of an age when belief in gods and spirits has been threatened by the quest for knowledge, by science and technology and the latter's gift of power over nature and fate. Not surprisingly, it is also an archetype for science fiction, all the way back to Mary Wollstonecraft Shelley's *Frankenstein, or the Modern Prometheus* (1818).

Modern fantasy, with its emphasis on gods, demons, and magic, rejects the rational-materialist view of reality. So does some SF. But there remains a dominant thread that can only be called Faustian. It insists that knowledge is all-important, and those who cling to myths, superstitions, and religions in the face of reason are fools at best.

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Sound familiar? It should. And if most of the embodiments of that familiarity are less than totally explicit about their Faustian character, there is still room for a Michael Swanwick to write a **Jack Faust** and remind us that even if there is no Devil for Faust to strike a deal with, the quest for knowledge for the technological age, still has a dreadful price to pay.

The tale begins with Faust burning his library. All those old books, full of lies and errors and delusions! Out with Aristotle, out with Galen, out with Scripture! What Faust wants is demonstrable truth. The question is where to get it, and since this is an age before the invention of science *qua* science—if not before the quest for knowledge—he tries his best to summon . . . well, not a demon. He knows there is no such thing. But if there is anything or anyone out there in the cosmos that knows everything, then it must know his powerful yearning. All he has to do is look within and focus and project that yearning, until . . .

Hello? What do *you* want, little worm? Just call me Mephistopheles (and wait till you see how that's *really* spelled!), and of course I'm not the devil. I'm just an alien creature that hates your kind right down to the ground, and I'll tell you whatever you want to know. You see, I'm quite sure the knowledge will destroy you.

Mephistopheles then proceeds to fill Faust's poor brain with knowledge far beyond his era. It takes Faust a while to get the hang of introducing it all to his world—building bit on bit rather than swamping the system with advances no one is ready for—but it is not long before the industrial revolution comes to Europe, long before it did in our own history. With it come notions of human rights, unions, revolutions, and so on. The new technologies Faust introduces—and perversely claims as his own discoveries—save lives but they also kill. They even cost Faust his one true love.

Yet it is clear that it is not science and technology that kill. Or rather, it is not only them. It is the human drive for power that harnesses whatever tools we have to destructive ends, and it is the success in that drive that pushes the drive to insane heights, with "insane" defined by Nazi ovens and more recent nuclear weapons.

Swanwick pushes his thesis enough over the top at the end that I suspect he is not himself that fond of science and technology. Indeed, he may even be among those whose thoughts seem to be colored by this logical equation: If knowledge is power, and power corrupts, then knowledge corrupts. Further, if more knowledge leads to more power, and maximum (absolute) power is maximally corrupt, then the more one knows, the more corrupt or evil one is. (Note that it follows from this that if one is omniscient, one must be Evil incarnate; thus God is the Devil.)

I thus have some trouble finding his viewpoint here all that reasonable. But *Jack Faust* is readable and entertaining, and it is exceedingly thought-provoking. Enjoy.

Tony Daniel's second novel, **Earthling**, has its points but did not much

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charm me. It begins with a portrait of the near future when the Pacific Northwest is even more than now the focus of conflict between radical environmentalists, loggers, park rangers, and scientists. A geologist, using a retired mining robot equipped with the partial memories of the geologist's mentor and named Orf, is tunneling deep into the crust, seeking the Mohorovic discontinuity. The environmentalist Matties (followers of the Matriarch) have effectively seceded from the Union and are trying to stop the robot's penetration of Mother Earth. Orf has discovered voices in the depths, intelligences at home in the magma. The geologist's one-time sweetheart, the mentor's daughter, arrives, rides into the depths with the robot, and when massive earthquakes strike ...

Jump to the future, years later, when the ranger culture protects the forest, and ranger Jarrod has broken a very basic proscription against reproduction (rangers recruit by fostering). He is sent off on a mission to take penicillin to the Yosemite rangers stricken by plague, and seek an answer to why compasses are losing their north. He finds his mother, discovers unbelievable savagery, and in the Napa Valley gains a tragically temporary love. In due time he fulfills his mission. And earthquakes once more destroy the world. Jarrod, protected by Orf, survives.

Jump again, and here is a new culture that communes in trances with the intelligences in the magma and with other worlds, that believes beauty is as much as physics an organizing principle of the universe, that is threatened by a planet-sized chunk heading faster than light toward Earth. The problem is to ward it off, to preserve Earth and civilization, but ...

The first two segments are nicely done and quite convincing, despite the magma dwellers. The third, however, I could not swallow. The leap from a material world that makes sense to a land of California mystic mush was just too much. I suspect *Analog* readers will agree.

Nancy Kress continues to work with biotechnology in her latest, **Maximum Light**. She begins by supposing a future whose biggest single problem is the decline in sperm count among human males. This is something we can see happening today, and some researchers are willing to blame it on the hormone-mimicking and disrupting effects of many of the synthetic chemicals we have released into the environment. Others are far more cautious, perhaps because our civilization is utterly dependent on these chemicals and everything we make with them. To do away with them would seriously cramp our style.

Yet if we *don't* do away with them ... This is where Kress comes in, portraying a world where you see gray-haired old farts at every turn and it's just going to get worse because most people can't have babies. Kids are scarce. Demand is high. Cloning doesn't work, at least for humans, and people are so scared of genetic engineering that the government has banned it and anything that smells of it (except for the medications that let the old farts keep getting older).

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Meet smart-assed Shana Walders. Far too cocky for her own good (hey, she's a kid, kids are a national resource, and besides, she's got great tits), she sees something she shouldn't while on a National Service gig, and gets very angry when everyone, even a Congressional committee, refuses to believe her. Kress plays it coy, but she doesn't take long to show the card: Shana saw chimps with human faces and hands created by "vivifacture," growing tissue from cell samples and shaping it on a template (in this case, the young chimps' skulls). Dressed, they look human enough to satisfy many a maternal urge.

Where did the human tissue come from? Meet Cameron Atuli, blithe (gay) ballet dancer. He doesn't remember much, for he has had memory surgery to erase some traumatic event, but it isn't long before Shana spots him and recognizes the face on the chimps.

Meet Nick Clementi, elderly scientist and government advisor. He gets involved, does a bit of investigating, and finds signs of a heavy-duty cover-up. Something strange and ominous is going on, and it has a lot to do with vivifacture, maternal urges, and what must necessarily happen when essential research is made illegal. (Remember the "If guns are outlawed, only outlaws will have guns" line?)

The *Maximum Light* title doesn't mean much till you reach the end of the tale, but I'll say no more than that this one easily lives up to the towering Kress reputation for thoughtful, interesting, well done SF. Too, it could easily have been serialized in these pages; if it had, it might well have won the AnLab vote in its category.

Phyllis Gotlieb is a Canadian poet and writer whose SF work reminds one of other authors' stories the way a Tiffany butterfly reminds one of a real butterfly: The original is there but refined and glorified far past the point where one might be tempted to grumble about imitation. That is, her latest novel, **Flesh and Gold**, reminded me a bit of several other authors—including Jack Vance and Gene Wolfe—but only in the best of ways. Gotlieb knows how to do it *right*.

Flesh and Gold's tale begins with a brief portrait of aquatic humanoids enslaved by surface dwellers, a human and a sauroid Khagoda, a hint that Gotlieb's far-future cosmos is one of diverse species. Next a Khagoda judge, Skerow, sits a case for colleague Thordh and convicts a criminal who protests that Thordh was supposed to let him off as he had done before. Walking in the streets of a polyglot city, Skerow then spots an aquatic humanoid female displayed in the window of a brothel and protesting her situation most eloquently and telepathically. Thordh is killed. So is a woman gladiator sent to infiltrate the brothel for the cops, while her partner Ned is assigned to infiltrate the gladiatorial resort world owned by the same folk.

And we are off on a tale of enslavement for the sake of wealth and power, of schemes and plots, bioengineering and cloning, all of whose intricately cross-linked threads come satisfactorily together in the end (al-

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beit a little too hastily for my taste). The result is an evolution of her 1992 story, "The Newest Profession" (in the *Ark of Ice* anthology), rewritten in a different time and place and with different characters, enlarged in scope and power, but still dealing with many of the same images and themes.

Highly recommended.

I suspect Jack McDevitt has a fair shot at bestsellerdom and a movie with his latest, **Moonfall**, a glorious attempt to pulverize civilization. It seems clearly based on the spectacular July 1994 encounter of Comet Shoemaker-Levy with Jupiter.

The tale begins during a total eclipse. On Earth, various folks are watching and marveling; out in the boonies, crazed militias await any sign of weakness that will give them their chance to reestablish a Republic of, by, and for Real Men. In orbit, the crew of the nuclear-powered *Percival Lowell* is ready for the Mars mission. On the Moon, US Vice-President Charles Haskell (among others) has arrived for the opening of Moonbase; Haskell is a Teddy Roosevelt fan.

At the height of the eclipse, amateur astronomer Tomiko Harrington spots a spark of light near the sun where no spark ought to be. Ace cosmologist and Nobelist Wesley Feinberg soon confirms the sighting, notes the new comet is a huge sucker (180 kilometers in diameter) moving very fast (480 kps, versus comets' more typical 40-50 kps), and calculates its orbit: In three days, it will spank Luna's backside. Hard.

Indeed. It will hit so hard that the Moon will be shattered into a cloud of debris. As one character says, "It'll be a hell of a show." Earth might even wind up with rings, like Saturn.

What will happen to Moonbase and the people there, including Vice-President Charlie Haskell, already setting up as a Presidential candidate? How about the L1 base? The Skyport Orbital Laboratory in orbit near Earth? Looks like an evacuation is in order, and if we use the spaceplane fleet and the *Lowell*, we have just barely time enough.

How about Earth itself? No problem, says a President who wants above all to quell all possibility of panic. The Moon's a looonng way away, and the situation is in hand—experts are in charge. There might be a few waves along the coasts, but don't worry. "Suure," say the people. "Which way to high ground?" Trains and planes are instantly booked solid, and the highways are nationwide going-nowhere-fast gridlock.

And the stage is set for an exciting disaster yarn. One little bobble in the evacuation routine, and Moonbase has to find six volunteers to stay behind. Charlie Haskell is one, very reluctantly—if he cuts and runs, he can kiss the election bye-bye, and besides, he said on the air that he personally would turn out the lights and close the door, last man out. Fortunately, a gutsy lander pilot thinks he can cut things very fine in the last few minutes, yank them out, and ride the blast wave hell-bent-for-leather, an omen raven on the wings of the storm, back toward Earth.

I don't really reveal much if I say he succeeds. Of course he does, or too large a chunk of the story would be

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truncated right there. And that blast wave is as impressive as anything anyone has imagined for years, just the thing for the Hollywood sfx wizards. It alone should make a movie inevitable.

So might the next stage of the catastrophe, as pieces of Moon and Comet Tomiko start hitting Earth. We're talking holes where towns used to be. Tsunamis big enough to scrub southern Florida clean.

And here comes the Big One. A monster shard of rock heading for Kansas, a dinosaur killer, and if nukes won't deflect it there's nothing left but to use those spaceplanes and push, dammit, push! Or else the end of civilization, the human species, perhaps even life on Earth.

Do they succeed? Well, there's plenty of can-do derring-do out there, with Vice-President Charlie Haskell hardly the least of it. Yet there is also a militia crew armed with heat-seeking missiles waiting to bring down a spaceplane, figuring the Big One's effects can only work to the advantage of Real Men.

McDevitt's catastrophe is so huge in concept and impact (sorry!) that the human factor becomes almost invisible. In a way that's a shame, for McDevitt has peopled his tale with a pretty convincing crew, actually a bit better than adequate to their tasks.

McDevitt has done a marvelous job in a classic tradition. I bet he had fun writing it, too. I'm sure you will, reading it.

Please note that the raunch factor here is very small. This one is suitable for children. It might even hook them into reading more SF.

* * *

Howard V. Hendrix's **Light Paths** is a sequel of sorts to his *The Vertical Fruit of the Horizontal Tree*, the chapbook expansion of "Singing the Mountain to the Stars" (1991), reviewed here in August 1995. In that story, an isolated tribe of South American natives (or are they descendants of the survivors of an interstellar shipwreck, millions of years ago?) combined the mind-expanding powers of their sacred mushroom with modern infotech to launch their mountain home into space. Its narrator is a character here, and the drug derived from the mushroom killed another character's brother, who left among his effects a super-computer package.

When that package reaches Seiji Yamaguchi on the Orbital Complex habitat, he asks a friend to investigate it. That friend plugs it into the Complex's computer net, and strange things begin to happen. Some of those things—a new computer game, and a flood of strange new satellites—alarm the authorities on an Earth heading rapidly for ecocatastrophe. Meanwhile, Roger Cortland is researching naked mole rats and scheming to invent a pheromone-based perfume that will both reduce human fertility and make women fight (that's what turns him on). In the end . . . well, Hendrix is trying to offer a solution to the world's problems, and he covers so much intellectual ground that he deserves a great deal of credit for that alone. But he also tosses in mushroom mysticism, telepathy, channeling, angels, and much, much more, including Philip K. Dick's information-bearing light beams. In the

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end, his novel feels like a barely controlled hodge-podge marred for most of its length by an enormous weight of expository dialog that—if the sentences were a bit simpler—would suit an old Tom Swift yarn ("Hello, Maude, did you know we've added a carburetor to the engine? It greatly improves control of the fuel flow." Carefully stepping on a cockroach, Maude replied, "Yes, Tom, and there are sparkplugs too so that the fuel doesn't just puddle in the cylinders. Why, that might be a fire hazard!").

The story's interesting, but Hendrix has a ways to go before he's very readable.

Laurie Silvers, president of BIG Entertainment, introduces **Isaac Asimov's History of I-Botics** by saying that once they had Isaac on the Board of Advisors of the fledgling Sci-Fi Channel, they asked him "to give us some ideas for a science fiction 'hero' who could be taken into young adult and illustrated novel formats; and true to Isaac's genius, he came up with exciting fresh ideas that formed the basis of the 'I-BOTS universe.'"

What we see here is World War II, a monster German robot, the Iron Man, that incorporates the mind of a nasty Nazi mad scientist and requires a steady diet of fresh brains from assorted innocent, lovely, and/or tormented prisoners. Elliot Hecht, American intelligence agent stationed in Switzerland to watch for trouble, is sent to an abandoned chalet, where he discovers the robot and is nearly killed. Meanwhile, the Americans back home are revamping and supercharging Golden Boy, a leftover from the 1939 New York World's Fair, and shipping it off to fight Iron Man. The battle seems decisive, but years later, the antagonists reemerge to square off once more.

The tale is told as a thoroughly illustrated series of fragments from diaries, reports, and narratives, with John Betancourt's "Prototype" providing necessary backfill. Karen Haber's "Don't Go Near the Pantanal" then informs us of strange robotic doings in Brazil (shades of the Boys!) and sets us up for Golden Boy's next heroic appearance.

Good fun, with powerful echoes of superhero comics.

At the 1997 World Science Fiction Convention, held Labor Day weekend in San Antonio, Texas, one of the guests of honor was Algis Budrys. For the occasion, the New England Science Fiction Association published **Entertainment**, a collection of ten stories from the early days of his career, plus a bibliography.

Budrys is today better known as the author of the novels *Who?*, *Rogue Moon*, *Michaelmas*, and *Hard Landing*, among others. He has been a book and magazine editor (currently of *Tomorrowsf*), a seminal critic/reviewer, a teacher, and more. And way back when in the 1950s, when I was a mere sprat who had not yet discovered the joys of SF, he was writing smooth, clever, insightful, sometimes bitter stories that ranked with the best work of the time and—though they smell of the era—can be read today with pleasure and a frisson of recognition of how often the ideas have been used by others since.

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"The Burning World" (1957) is a good example of Budrys' work. Its premise is that the discovery of free energy has led to the downfall of the Soviet Empire and the liberation of the common folk. However, the human urge to dominate remains and ruthlessness can still be necessary. It is no coincidence that Budrys is an expatriate Lithuanian.

This one is well worth the price.

Briefly noted: **In After Contact: The Human Response to Extraterrestrial Life**, Albert A. Harrison (a psychologist who has written much on the psychology of space exploration), gives us a very interesting survey of the SETI (Search for Extraterrestrial Intelligence) effort, its justification and rationale, and false alarms (notably including UFO "sightings"). The coverage of the biological, psychological, and social nature of possible ETs, and of how human beings and human society might respond to contact, is also interesting, although it suffers seriously from being inescapably speculative. It's nice to see the questions being considered seriously by academics, but SF readers are likely to enjoy more an SF approach.

Briefly noted: Paul Halpern's **The Quest for Alien Planets: Exploring Worlds Outside the Solar System** gives SETI and contact its last chapter, but devotes the rest to astronomers' search for extrasolar planets. That search has been successful in that a number of worlds have been detected, but unsuccessful in that no one has spotted anything like Earth. Yet our equipment is just barely at the threshold of competence here, and even so we have learned that the Sun is not alone in having worlds. Soon, perhaps, we will spot potential homes for ETs, and then, with luck, we may exchange greetings.

If you've been reading *Analog* for the last few years, you might think you don't need Robert Zubrin's **The Case for Mars**, but you'll probably want it anyway. You might also want to give it as a gift to people who might be interested in seeing Mars colonized, but aren't convinced of either the feasibility or the desirability of such a project. Zubrin makes a strong, clear case for both.

Analog has published several of his articles on his highly original schemes (some of which have now been embraced by NASA leaders) for exploring and colonizing Mars; but this book lays out the whole picture in a comprehensive, well-integrated way that you haven't seen elsewhere. The "how-to" is here, with the more technical details set apart for the benefit of those readers who might prefer to skip them. But the book also gives ample attention to the "why," beginning with a survey of the history of our fascination with and learning about the red planet, and ending with an epilogue on what a Martian frontier might do even for the many who don't actually go. In between, is a detailed, methodical development of the challenges of exploring, colonizing, and perhaps even terraforming Mars, and what can be done about meeting those challenges. I

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noticed very few errors, and none that affected the overall thrust of Zubrin's argument.

Zubrin's central thesis, as many of you already know, is that human exploration and colonization of Mars does not have to be anywhere near as expensive as commonly assumed (the key being the extensive use of indigenous Martian resources instead of carrying everything from Earth). But he also makes the crucial point, often overlooked, that some goals that can be reached on a fairly short time scale will never be achieved at all if too much time is allowed for them. This is one of them. So if you're at all interested in getting our species established on another world, and on its way to the stars, now is the time to do what you can to make sure that happens. Getting this book into the hands of anyone who might help is a good first step—especially since the recently released paperback makes that easier than ever. ■

IN TIMES TO COME

With our June issue, *Analog* goes to a new format which should benefit everybody. It's not a big change—a slight increase in page size—but we have reason to believe it should improve our visibility and sales on newsstands. And there are even more direct and immediate benefits for you, our readers. Even though our new issues will have fewer pages than the old, the new pages hold so much more text that the overall effect is an *increase* in how much we can put it in an issue, equivalent to something like ten pages in the old format. That's enough to accommodate an additional short story in each issue, or a novella where formerly we might have had room only for a novelette. We're quite enthusiastic about the potentials of the new and roomier format, and think you will be, too.

Our June cover is by the versatile Wolf Read, for his own story "Spindown." It's something of a departure from his earlier stories here, which have tended to focus on quite young characters. Here his protagonists are very old indeed, but they're watching the end of something even older. One of the sadder parts of old age has always been the inevitability of watching the end of old friends and familiar places, but when you're practically immortal, the poignancy of that rises to entirely new levels. . . .

We'll also have stories by Charles L. Harness, Ron Goulart, Michael A. Burstein, and Paul Levinson. Burstein's is an anniversary tribute to someone who made a well-remembered mark in these pages; Levinson's is a sequel to his popular novelette, "Loose Ends." Dr. Levinson also supplies the fact article, "The Book on the Book: A Prognosis for the Page in the Digital Age." Last but by no means least is Part 3 of Joan Slonczewski's *The Children Star.*

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BRASS TACKS

Dear Stan,

Just finished the December issue and decided that there were a few things worth commenting on. (There always are, but time is short so I seldom do anything about the notes that each issue is adorned with.)

First, an apology to Fred Pohl. I've read his works for almost forty years, but ignored them for twenty years. A magazine version of one of his stories didn't set too well with me, so I avoided his work until 1991 when I started his Heechee novels. I say I owe him an apology because I missed some very good work by an excellent author. Even the one that I didn't like years ago I have since re-read and enjoyed. "O Pioneer!" is good, but I think it wrapped up things a little too swiftly. Maybe the book version will be a little more "meaty."

Your editorial was excellent, and points out something that many people either have forgotten or just never knew, that things are more complex than we often think. The extinction of large mammals in the New World most likely had a combination of causes. I admit that sometimes in thinking about problems, mainly social, I think too simplistically, even though I "know" that the problems are complex and can't be solved by simple means.

"Biology at the Extremes" gives a lot of good ideas for stories, as well as an update on what we know about the conditions under which life can survive. John Cramer's article on the SSC missed, in passing, that there was an outcry about the location of it, when one of the possible sites was northern Illinois. A lot of the farmers in the area did not want anything to do with it, and were afraid that it would ruin their crops. I know because I lived in the area at the time.

One more note—It's good to see new works by Charles L. Harness. The first "adult" science fiction I read was a magazine version of his "Flight Into Yesterday" back when I was nine or ten. Over thirty years later I found the book version, and learned who wrote it. Then he appeared in your magazine a couple of years later. Good.

Keep up the good work. I've enjoyed *Analog* for almost thirty years, and hope to enjoy it for at least as many more.

STAN WINCHESTER
greyrover@aol.com

In general, our serials are exactly the same as their book counterparts, and I have no reason to believe this one will be different.

Stanley Schmidt

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Dear Dr. Schmidt,

I am writing in response to your editorial "E. Pluribus *How* Many?" from the December issue of *Analog*.

Your idea that some prehistoric mass extinctions may have resulted from multiple causes as opposed to a single cause was provocative, especially when it led to the issue with Occam's Razor.

There does seem to be a possibility that you may have missed, however.

Your ideas reminded me of the same problems that surround the treatment of tuberculosis. Usually, two or three different medications must be used at the same time over a period of several months in order to kill enough of the bacteria so that the immune system can get caught up on its job.

If a patient uses only one medication at a time, *Mycobacterium Tuberculosis* may be "beaten down" (treated enough to become asymptomatic) for a time, only to flare up later in a drug-resistant strain.

That is the reason why two or three medicines must be used at the same time: as we want to hit the organism in as many different ways as possible so that the survivors of one weapon are killed by another, which makes Darwinian selection much more complicated for the bacilli.

In any event, these medicines work in very different ways. Some may sabotage the cell wall and cause the bacilli to explode from osmosis, while others may bind to a ribosome, which keeps the organism from reproducing.

In my example, the mechanism behind the extinction of the tuberculosis bacilli in a human body has a common cause in a physician, even though the medicines are very different in their structures, origins, and chemistry.

If we assume that chance caught up with these prehistoric species, can't we attribute their multi-faceted extinction to probability and still satisfy Occam's Razor by implicating the laws of statistics?

KEVIN LEVITES

Dear Stan,

Yes! Yes! A thousand times Yes! (Re: "E Pluribus *How* Many?" De.c 97)

As you say, even scientists fall into the trap. *Either* true *or* false. *Either* heredity *or* environment. *Either* a wave *or* a particle. The urge afflicts us all; we prefer problems that give us a simple choice. If it's not "A" it must be "B," we reason, assuming them to be not only mutually exclusive but collectively comprehensive. Often that is a poor assumption.

The universe is complex. If we try to understand it in terms of simple dualisms we invite failure. A coroner sometimes has trouble determining "the" cause of death for an individual. The extinction of an entire species is likely to be much more complex and less easy to attribute to a single cause.

An ecology, such as the web of lifeforms here on earth, is intricate and ever-changing. I know of no formalism that would serve to represent the totality, with its myriad interactions and interdependencies. I will postulate that this complex structure must be at some times more "unstable" than at

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others. A small disturbance may produce a large chain of consequences. Internal "catastrophes" may occur when a series of dominoes falls for no apparent reason. Surely an asteroid impact, releasing mega-megatons of energy and possibly triggering volcanic activity, must produce quite a quiver! But it doesn't have to be "the" cause; there may be many causative factors, none of which dominate.

We need not limit our conjecturing to such physically spectacular events as meteor impacts. Biology, or biochemistry, offers all sorts of possibilities. I don't mean just the cliché of deadly plagues, though they are certainly among the possibilities. Imagine, for instance, what might be the present toll of the AIDS virus, had it been an air-borne contagion. I'm thinking more of the normal competitive struggle among life-forms, which ebbs and flows with each evolutionary step. These steps are usually small, so that the competitors have time to readjust. But every once in a while there must be a big advance, which might totally extinguish the competition. Which in turn might lead to other dependent species being jeopardized, etc., etc.

Again, thanks for the reminder. I sometimes feel that the most profound truths are those which, once enunciated, seem obvious.

WARREN RAYLE
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Dear *Analog*,

Wrong again. The extinctions of large animals in North America were almost certainly caused by the arrival of sophisticated human hunters: the 'blitzkrieg' hypothesis. The other hypotheses: climatic change and the introduction of new pathogens, are clearly wrong, and are in fact driven by political considerations for the msot part, rather than any evidence. There is strong aversion to the idea that the early Amerindians could have wiped out lots of species, and it has caused supposedly intelligent people to embrace completely ridiculous notions.

The climate idea is silly, because the glaciers came and went many times in the last two million years, with lots of wild variations in climate along the way, without ever wiping out most of the big mammals in the Americas or anywhere else. There have been other big local extinctions in the past few tens of thousands of years, but every one of them happens to coincide with human settlement. There was megafauna in Australia, with wombats the size of hippos and marsupial pseudo-lions, and it all went away after the Aboriginals arrived, which was a long time before the Amerindians settled the Americas. The moas of New Zealand disappeared rapidly after the Maoris arrived—do you really think that the climate just fell apart in 1000 A.D.? I think we would have noticed. Shortly after Madagascar was settled, the world's heaviest flightless bird disappeared, as well as many other species, including a lemur as large as a man. What odd climatic perturbation caused that?

The idea that human invaders

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brought new pathogens that played a significant role in the extinction of the American megafauna is also hogwash. First, why would these imagined pathogens only wipe out large animals? The only animals that disappeared were large mammals and the predators and scavengers that depended on them. Smaller animals did not suffer any wave of extinctions. Human pathogens are not particularly likely to devastate other species, even other mamallian species. They're not adapted to those other species. Next, the Amerindians didn't bring many pathogens along with them. Only a few diseases can persist long in small populations of subarctic hunters, and that's who made the initial settlement. The only domestic animal carried over from Asia was the dog.

Infectious disease certainly can occasionally kill a significant number of large mammals, but we know of no example where it has caused extinction. Rinderpest killed up to 90% of some ungulate species in the great outbreak in Africa in the early 1900's, but I know of no resulting extinctions. Populations recover rapidly from that kind of crisis. Think of another example: when Europeans colonized the Americas, they brought over a vast number of new pathogens, including many that must not have even existed in humans back during the original settlement of the Americas. They brought over many species of domesticated animals with their associated pathogens, and managed to introduce tropical diseases that had never managed to cross the Bering Strait. The Ameridians certainly suffered from this new wave of human-adapted pathogens, but what mammalian species became extinct as a result of the Columbian exchange? Was it whitetailed deer, or moose, or black bears, or prairie dogs, or bison? None of the above. It never happened. If no extinction resulted from this tremendous injection of new pathogens, we can be sure that a small group of half-frozen proto-Eskimos didn't do it either.

No, Indians ate the megafauna. The animals that became extinct are just the ones that a hunting tribe could make a good living off of. A tribe of Neolithic hunters can track and kill anything, but only the larger animals have high payoff. The process was much more rapid than in the Old World because the animals were not at all adapted to humans and never got a chance to be. In addition, the fact that the New World had no pathogens adapted to humans, and that the Amerindian settlers brought few with them, must have led to accelerated human population growth.

Truly, barbecue is *the* American tradition.

GREGORY COCHRAN

Dear Dr. Schmidt,

It is all so clear now! I had never put it together before! All this technology coming so quickly and then the randomizing of the entire effort to the point where we can't seem to grasp the mainstream! Who could have known?!?!? Thank you Arlan Andrews Sr. ("WWW: The Web We Wove"), for making the world realize something I had known from the beginning. The breakup of the Phone

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Company has to have been the most asinine thing we've done this century. Instead of being a boon to the consumer, it has merely been a boon to all the myriad phone companies that have seemingly sprouted out of thin air (another dimension??, another history??). While my own disgust at the situation didn't result from losing contact with another dimension, I have had the personal misfortune of trying to locate a toll-free number. The search took me through four (4) different toll-free phone companies and the result was I still didn't have the number I was looking for. (I did finally get it through a friend). This is PROGRESS? Bring back Ma Bell.

William Seiler
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Dear *Analog*,

After reading Richard Meisner's article "Cosmological Darwinism" (November 1997) I thought of an objection to the idea of evolution driving gradual changes in the laws of spawned universes that did not seem to be suggested by the author. There is no competition for resources. It is not necessary that a universe be a better reproducer, just that it can reproduce, at least once. If my understanding is correct, a universe does not need to feed, and two universes do not exist with any spatial reference to each other. It seems to me that any variation of universe that survives long enough to spawn others would continue to spread. There being an infinite amount of resources, random mutation would cause an infinite number of "species" of universes.

Despite this objection I very much enjoyed the article. Perhaps there is some mechanism for inter-universal competition. We may find that the conditions in our universe maximize rate of reproduction. If so, maybe we should be worried that our universe could be eaten by another.

MATT NELSEN

Dear Editor Schmidt,

I was surprised and pleased that Tom Easton discussed my book *Postmodern War* in his column, "The Reference Library," in your November '97 issue. Surprised because I'd expected you to review *The Cyborg Handbook* which I edited (Routledge, 1995) but you never did. Pleased because he did spell my name right, and that is the essential element of good publicity. However, a few of his comments were less satisfying.

I hardly have a "jaundiced view of the human animal" since I argue that while war has many attractions it is not an inevitable part of human nature. Unlike Jerry Pournelle and many other future-war writers I don't think it is necessary that "There Will Be War!" as they are likely to proclaim. I'm also sorry that Easton didn't mention that besides much analysis of state-of-the-art weaponry and its (mis) uses, especially the role of artificial intelligence as a weapon and metaphor, I also have a whole chapter on the relationship of science fiction to contemporary military policy including stuff about Robert Heinlein's World War II work that has only been published in an academic article I did a

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few years ago for *Science-Fiction Studies* ("'There Will Be War!': Future War Fantasies and Militaristic Science Fiction," #64, vol. 21, Part 3, November 1994, pp. 315-336).

Finally, I'm not sorry that Easton pointed out that my work is one of high theory (although he got lost in it). It is an academic book, after all, and besides there are some things (such as contemporary war and why it survives in human culture even though it directly threatens the human future) that really can't be explained both plainly and accurately, even by Ben Bova (the paragon of style Easton urges me to emulate).

I promise my next book, *Cyborg Citizen*, which explores the political implications of our increasingly cyborged society and proposes a Cyborg Bill of Rights, will be written with a general audience in mind, although I'll aim more for Ursula Le Guin or Bruce Sterling than Bova. In any event, thanks for the mention. Your readers can find out more about *Postmodern War* and cyborgs, among other things, at my web site: http://www.ugf.edu/CompSci/CGray/istpg.html.

PROF. CHRIS HABLES GRAY
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UPCOMING EVENTS Anthony Lewis

1-3 May 1998
MAGIC CARPET CON IV at the Radisson Read House, Chattanooga, TN. Guest of Honor—Elizabeth Moon; Artist Guest of Honor—Larry Elmore; Filk Guest of Honor—The Ropers. Info: Magic Carpet Con, 211 Highland Ave., Smyrna, TN 37167; (500) 367-622; e-mail: SusanB14@aol.com

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1-3 May 1998
MARCON 3.3 (Central Ohio SF conference) at Hyatt Regency, Columbus, OH. Guest of Honor—Lois McMaster Bujold. Info: (614) 475-818; e-mail: info@marcon.org

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1-3 May 1998
ROC*KON 22 (Arkansas SF conference) at Little Rock Hilton, Little Rock, AR. Artist Guest of Honor—Jamie Murray; TM—Libby Singleton. Registration: $20 in advance. Info: Roc*kon 22, Box 24285, Little Rock, AR, 7222;. Fax: (501) 224-0204; e-mail: roc_kon@hotmail.com

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15 May 1998
VCON 23 (British Columbia SF Conference) at The Surrey Inn, Surrey, B.C. Guest of Honour—David Gerrold; Artist Guest of Honor—Mike Jackson. Registration: C$30 until 1 March 1998, C$35 after, C$40 at the door. Info: VCON 23 c/o Les Shewuk, #316-4683 Arbutus St., Vancouver BC V6J 4A3, Canada. (604) 261-4895. e-mail: les@portal.ca

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22-25 May 1998
DISCLAVE '98 (Washington D.C. area SF Conference at Ramada Inn, New Carrollton, MD. Guests of Honor—Terry Bisson, Gene Wolfe, and Nicholas Jainschigg. Info: Disclave 1998, c/o Joe Mayhew, 7-S Research Road, Greenbelt, MD, 20770-1776. e-mail: mail@wsfa.org; URL: http:/www.wsfa.org

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5-9 August 1998
BUCCONEER (56th World Science Fiction Convention) at Baltimore Convention Center and nearby hotels, Baltimore, MD. Guests of Honor—C. J. Cherryh, Milton A. Rothman, **Stanley Schmidt**, and Michael Whelan; TM—Charles Sheffield. Registration until 15 June 1998: $130 (£94), supporting $30 (£22), children +4 to 12 $65 (£47), children .75 to 4.0 FREE. (These are the latest posted rates as of the time this column went to press.) Info: Bucconeer, Post Office Box 314, Annapolis Junction, MD 20701. e-mail: bucconeer@bucconeer.worldcon.org; Web page: http://www.bucconeer.worldcon.org ■

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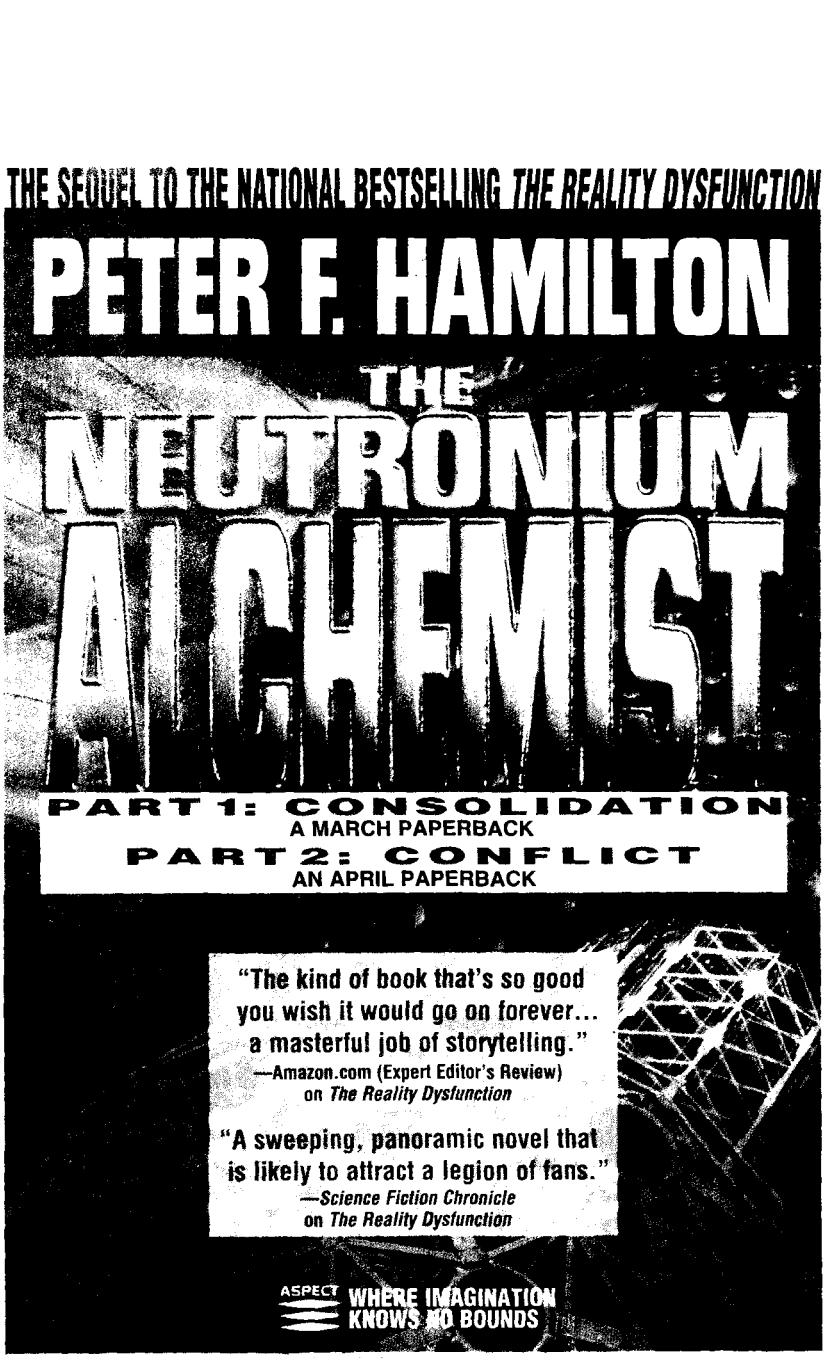

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